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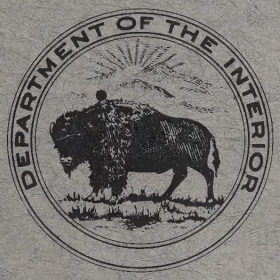

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TABLE OF CONTENTS

Page

HUNT CREEK FISHERIES Experiment Station, by A. S. Hazzard, J. W. Leonard, and D. S. Shetter 65
2,4-D AND SOME Emergent Aquatics; by A. C. Bauman 71
THERE IS NO "Universal" Pondfish, by T. K. Chamberlain 78
FISHERY MANAGEMENT in Oklahoma, by A. D. Aldrich 83
GROWTH RATE AND FIN Regeneration in Trout, by J. H. Wales 86
ONE FISH-CULTURIST'S Estimate of the Kingfisher, by C. L. Fuqua 90
DUAL TREATMENT for Bacterial Fin Rot, by G. J. Eicher 94
COMPRESSED-AIR Fish-Feeding Apparatus, by John Pelnar 97
WELL CASINGS for Pond Screens, by F. A. Thompson 99
BARREL-TILTING Rack, by B. T. Gillette 101
SCREEN FRAMES That Seal, by W. M. Allen 103

From Publications
Reprint:
Use of Derris to Reclaim Ponds for Game Fish, by H. R. Siegler and H. W. Pillsbury 104
Abstracts:
Survival and Growth of Fingerling Trout Reared under Different Hatchery Conditions and Planted in Fast and Slow Water, by H. A. Schuck and O. R. Kingsbury 110
The Disinfection of Trout Eggs Contaminated with Bacterium salmonicida, by L. L. Gee and W. B. Sarles 111
Fischereiwissenschaftliche probleme in deutschen Alpenseen, by Wilhelm Einsele 111
Limnological Studies in Connecticut VIII. The Niacin Cycle in a Small Inland Lake, by G. E. Hutchinson and J. K. Seton 111
Calculation of Fish Condition from Scale Dimensions in the Bluegill, Lepomis macrochirus, by H. B. Chase 112
Preliminary Report on Farm Pond Management in Michigan, by P. I. Tack and W. F. Morofsky 112
Observations and Experiments on the Cave Fish Pimelodella kronei and Its Relatives, by C. Pavin 112
Preliminary Observations on the Storage of Milt of Trout, by A. D. Butcher 112

Features
Question Department 77
Clearing House 113

Items
Strange Specimens from Guatemala 70
Back Issues of the P.F.C. 89
Origin of Fish--Plato 89
Feeding Fingerling Catfish 93

The PROGRESSIVE FISH-CULTURIST
News and Views from many Sources on Practical Hatchery Problems

Volume 9 Chicago, Ill. April 1947 Number 2

HUNT CREEK FISHERIES EXPERIMENT STATION

MICHIGAN'S FIELD LABORATORY AND EXPERIMENTAL AREA ENGAGED PRIMARILY IN STUDY OF TROUT-STREAM PROBLEMS

Albert S. Hazzard, Justin W. Leonard, and David S. Shetter
Michigan Department of Conservation
Ann Arbor, Michigan

AS EARLY AS 1935 members of the staff of Michigan's Institute for Fisheries Research felt the need for a field experiment station where trout problems could be investigated continuously and more intensively than was possible by field trips from a central laboratory in the southern part of the State. A major purpose of the creation of such a station was to provide comfortable living quarters and good facilities for men assigned to investigations of trout throughout the year but especially during the winter (which may be the "bottleneck" in trout production).

In 1938 approval was given and funds were made available by the Michigan Conservation Commission for the establishment of a field laboratory and experimental area to be devoted principally to the investigation of trout-stream problems. After carefully examining various streams in different parts of the State, Institute staff members agreed on a section of the headwaters of Hunt Creek, a tributary of Thunder Bay River, in the northeastern part of Michigan's lower peninsula. With the exception of two small private holdings on minor tributaries, all the stream frontage was already State-owned; the stream system itself seemed fairly typical of the many smaller trout streams of this part of the State; its size was such that it could be worked by a relatively small number of men with ordinary equipment; it was known to be little affected by ice formation; and, though off the main roads, it would be relatively accessible the year around.

The experimental area embraces about 3 miles of Hunt Creek, as well as six of its tributaries (of varying importance) which range in length from about 1/6 of a mile to 2-1/4 miles. On tributaries of Hunt Creek there are four small lakes (more properly called ponds), two of which contain brook trout. The water supply of the system is derived almost wholly from

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Contribution from Institute for Fisheries Research, technical branch of the Division of Fisheries, Michigan Department of Conservation.

Combination laboratory and residence.

(Photos by Mich. Cons. Dept.)

springs. The country is hilly; there are swamps of tag alder, cedar, balsam, and tamarack along some portions of the stream system. The uplands formerly supported good stands of red and white pine but now are mainly forested with second-growth aspen, white birch, maple, and oak. The soil is largely of sand and gravel, which absorb rainfall and minimize floods.

At the lower end of the experimental area the average flow is about 22 cubic feet per second. The slope of the stream bed is considerable; through most of its course the surface velocity is between 1 and 2-1/2 feet per second. Through the upper reaches of the stream, dense cover is provided by white cedar swamp. Then the course enters a relatively open and marshy area--the scene of former beaver activity--where clumps of alder provide varying amounts of shade and cover is largely restricted to the slightly undercut banks. Below the marsh, the stream flows between high banks that support a mixed growth of aspen, balm-of-Gilead, and oak, with occasional clumps of white cedar, spruce, and balsam along the edge of the water. After more than half a mile the character of the streamside gradually reverts to swamp conditions, including dense growths of white cedar and tamarack. Here, however, the swamp forest seldom extends to the shoreline, and the stream receives considerable sun. The stream flows through swamp for about 1,800 feet, then enters a broad, open, marshy meadow which continues for a little more than half a mile to the lower end of the experimental area.

Through the upper marsh area the stream bottom is composed largely of silt, fibrous peat, and sand. In the high-bank and cedar-tamarack swamp sections the bottom is predominantly gravel. The lower marshy section is very sandy. Thus, the experimental area provides examples of the major types of bottom material and bank-cover which characterize many of the trout streams of the State.

Construction of the physical plant began late in the summer of 1939. Present facilities include a frame building that houses the office and laboratory, quarters for transient investigators, and an apartment for the resident biologist. The basement provides space for a small workshop, garage, darkroom, tanks, and troughs in addition to the heating plant. The building is provided with central heating, running hot and cold water, and "high-line" electricity. A 3-room and a 1-room cabin at other points on the area provide accommodations for permanent and part-time assistants. A series of three stream-channel diversions totalling about 600 feet in length was constructed in 1940; screen-holding bulkheads permit experiments with known fish populations under fairly natural conditions. Counting weirs have been installed on five tributaries that enter Hunt Creek in the experimental area. A water-level control dam and two-way fish trap have been built at the outlet of East Fish Lake (largest of the fish ponds), and a fish trap has been placed on the inlet.

At present, the station staff is composed of the resident biologist, who is in charge; one trained permanent assistant; and three temporary assistants employed for the duration of the trout season. Necessary laborers and construction workers are engaged locally on a temporary basis. Various members of the Ann Arbor staff of the Institute spend considerable time at the station working on special projects.

The broad goal of the station's research program is the development of practical methods for determining accurately the carrying and productive capacities of trout streams and lakes, and for increasing these capacities as far as may be economically feasible. Specific investigations now under way include:

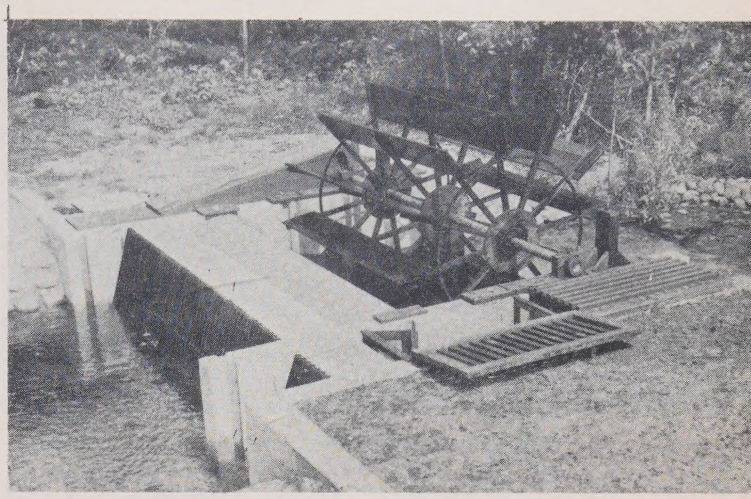
1. An intensive creel census, which will start its ninth consecutive season in 1947. From this are obtained complete yield records for the various parts of the experimental area and incidental information on catch per hour, types of lures used, and fluctuations in quality of angling. Scale samples and weight-length data are taken to provide information on age and growth rate. Stomachs are secured at intervals for food analyses.

2. A study of fish movements throughout the experimental area by means of counting weirs installed in each of the major tributaries. Results from weir operations are throwing light on the much-argued question of the desirability of closing tributaries as "nursery streams," as well as on brook-trout migrations generally.

3. A general study of brook-trout spawning and the results from natural reproduction. This has involved redd counts in the experimental area each fall since 1944, also the confinement of known numbers of males and females in one of the blocked-off diversions until they have completed spawning, their subsequent removal, and the counting of the surviving progeny late the following summer. In another phase of this work, a single female and one or more males are confined in another diversion and allowed to spawn, after which the adults are removed. Observations are made as to the number of redds fanned by the single female, and the nests are dug open later to determine how many redds actually were utilized for egg deposition.

During the fall just past (1946) the brook trout resident in East Fish Lake were observed to spawn within the confines of the lake for the first time. In order to determine whether or not their reproductive efforts were successful, wooden frames (2- by 2- by 2-feet, covered on five sides with screen wire) have been constructed and driven into the bottom, enclosing egg pockets at two different sites. Use of frames should facilitate determination of the success or failure of the spawning attempts in this unusual site.

4. Population studies of trout streams and the techniques used in making such studies. This general field is regarded as one of the most important in present-day trout-stream research; methods which will result in accurate counts will aid in answering many questions that now baffle the investigator and the trout-stream manager. The most efficient tool found thus far for this work is the electric "shocker," originally described by Haskell (1939) but modified somewhat, in the light of experience, both in the hook-up and in the type of electrode used.



Two-way fish weir with self-cleaning rotary screen.

Studies on the area to date indicate a wide variation in the population of different stream sections at the same time and a wide variation in the same section at different seasons of the year. Shetter and Leonard (1943) reported on a population study of a short section of Hunt Creek in September 1940, in which a population of approximately 94 pounds per acre of brook trout was found. Studies conducted over the identical water between September 1942 and September 1943 yielded data that indicated a brook-trout population which varied between a low of 44 pounds per acre in January 1943 and a high of 86 pounds per acre in September 1942, despite the fact that this small portion of the stream was closed to fishing after the first study.

5. A study of the interrelated effects of increasing a known fish population which is existing on a known food supply. During November 1946 the wild fish population of one of the open diversions was removed by use of the shocker after blocking off the diversion with 1/4-inch mesh screens; all fish were measured, weighed,

Seining in connection with trout population study.

and marked. While the native fish were held in tanks, bottom-food samples of the four types of bottom in the diversion were taken to determine the food supply. The original population was doubled by obtaining additional fish from the stream below the experimental area. The introduced fish were weighed and measured and given a mark different from that used on the native population. All fish in the experiment will be weighed and measured from time to time to determine changes in average growth and condition, and the supply of bottom food will be examined every 2 months. A detailed map of the diversion has been prepared as an aid in checking physical changes and to make possible more accurate estimation of total bottom found at any given time.

6. A study of the effect of lowering the legal-size limit on brook trout in Hunt Creek from 7 inches (total length) to 6 inches. Under special regulations promulgated by the Conservation Commission, anglers are permitted to retain 6- to 7-inch brook trout from four designated sections of Hunt Creek. The effect of this removal of an additional size-group of brook trout, starting with the 1946 trout season, will be followed carefully by means of the intensive creel census. In addition to the usual information on anglers' catch, measurements and weights of the 6- to 7-inch brook trout will be obtained for the records. The effect of the removal of this smaller size-group of fish should be apparent in the catch during the next 2 years.

7. The maintenance of general ecological records on the area to provide a basis for the appreciation of gradual changes in the environment. As a foundation for this phase of the program, a detailed map of the stream and its tributaries was prepared on a scale of 1 inch = 20 feet. Fixed stations were established for repeated photography of certain sites at regular intervals.

In addition to those described above, numerous experiments of short duration are conducted. These include actual field tests of new designs for experimental apparatus, tests of various chemical agents

Electric shocker in use. Portable generator on stream bank.

reputed to control noxious aquatic insects with minimal damage to fish, and similar short-term investigations.

Two research projects which have been completed since the description of the Station and its activities by Hazzard (1940) are those concerning the efficiency of planting fingerling brook trout in streams, and an analysis of the value of stream-improvement devices in producing better fishing. The experiment with brook-trout fingerlings from a nearby rearing station involved the fin-clipping of approximately 53,000 fish for release in 1939 and 1940. Returns on the marked fish were obtained by intensive creel census, random creel census, and voluntary report. The results demonstrate that in the Hunt Creek drainage, where there is more than adequate natural reproduction, plantings of hatchery-reared brook-trout fingerlings are superfluous. It appears very unlikely that any more than 3 percent of the fingerlings released will survive

to reach legal size and further that such survival is at the expense of naturally produced fish.

An 8-year study of the value of stream-improvement devices in a portion of the experimental waters of Hunt Creek indicates that pool-forming deflectors improved the angling quality (as judged by the number of pounds of fish caught per hour) an average of 46 percent, based on average data obtained for a 3-year period before improvement compared with those for

Electric shocker in use. Seines backed with chicken wire to block off section under investigation.

a 5-year period after installation of the devices (Shetter, Clark, and Hazzard, in press). Since this study has been completed, two other stream sections with different environmental characteristics have been improved. A different type of deflector construction has been tried in an effort to make a structure which can be put in with a minimum of labor and equipment, and which will have the least possible maintenance cost. Again the creel-census data, population analyses, and food studies on these sections will provide the final answer as to the true value of the work that has been done.

Leonard (1942) has published observations concerning the relation between natural food present in the stream in midwinter and the food found in the trout stomachs at that time. He noted that the percentage occurrence of food items in the stream-bottom samples differed noticeably from the percentage occurrence of food items found in the trout stomachs. For

Electric shocker in use where natural obstructions make conventional seining almost impossible.

example, volumetrically, larvae and pupae of midges and black-flies made up 84.7 percent of the diet but only 56.9 percent of the bottom fauna; mayfly nymphs formed only 7.5 percent of the diet but were 24.8 percent of the bottom fauna. It was further observed that the digestive rate of the brook-trout fingerlings collected during the midwinter was extremely slow. Three hours after removal of trout from the stream, midge and blackfly larvae and aquatic annelids found in the stomachs were still vigorous enough to crawl around the watchglasses.

The onset of World War II interfered to a large degree with portions of the research and construction program planned at the station, and with the writing-up of several phases of investigation which had been completed. In the latter category are analyses of the results of various population studies, results of the monthly seinings for marked fish, an analysis of the brook-trout scale-sample collection (which amounts to several thousand fish of all sizes), observations on the relative growth and mortality of hatchery-reared and wild brook-trout fingerlings and the comparative feeding habits when the fish are held in the same natural raceway, and an analysis of a 5-year study involving the yearly release of a known number of hatchery fingerlings into a natural raceway containing a known population of wild brook trout. It is the ambition of all connected with the work at the Hunt Creek Fisheries Experiment Station to publish eventually all unreported data worthy of printing.

Close-up of electrode used with electric shocker.

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STRANGE SPECIMENS FROM GUATEMALA

More than 28,000 fish specimens have already been collected in Guatemala in the course of a fish and game survey conducted under the sponsorship of the Smithsonian Institution, the Fish and Wildlife Service, and the State Department. Among the rarities noted thus far are a fresh-water shark and a fresh-water sawfish, both of which may prove to be previously unrecognized species; a fresh-water catfish that has queer incubation habits; and two varieties of the gymnotus.

Apparently the male catfish incubates the eggs in its mouth. There is evidence, too, that the fry return from time to time to the male parent's mouth for shelter. Presumably the parent fasts while its mouth is thus occupied.

2, 4-D AND SOME EMERGENT AQUATICS

EFFECTS OF BUTYL ESTER OF 2,4 - DICHLOROPHENOXY ACETIC ACID ON SOME EMERGENT AQUATIC PLANTS

Aden C. Bauman
Missouri Conservation Commission
Jefferson City, Missouri

THE PROBLEM of obnoxious emergent aquatic plants varies with many factors, the more important of which are: the region of the State, the species native to the region, the soil type, and the extent and depth of water. There is hardly a region in which all types of water are free of obnoxious plants or weeds. A plant serving well in a large lake may become obnoxious if it invades the hatchery pools or ponds; a weed may be defined as a plant growing in a place in which it is not desired.

Although water lotus (Nelumbo lutea Willd.) is well behaved in some parts of the country, it becomes a nuisance in others. This is likewise true of spatterdock (Nuphar). In hatchery pools, in small farm ponds, and in shallow lakes cattail (Typha), arrowhead (Sagittaria), waterwillow (Dianthera), waterprimrose (Jussiaea), and several of the pondweeds (Potamogeton spp.) may produce a growth that chokes the water.

Conditions may differ within a State, so that a species may be absent in one region but obnoxious in another. For example, in Missouri the water lotus, commonly called yonkapin, is rarely found (except as weak growths) in the upland lakes and ponds. In the lowlands of the large river valleys, however, this plant grows so vigorously that shallow lakes and duck marshes become choked with beds as much as 300 acres in area. In shallow areas of farm ponds and in marsh areas, cattail grows in dense beds. Arrowhead often "takes" small ponds and the shallow parts of larger lakes but grows only as a narrow bed along the shore of deeper waters. The same is true of pickerelweed (Pontederia), sweetflag (Acorus calamus L.), and waterplantain (Alisma). In the State of Missouri, as these larger weeds choke a water area and reduce wave action, the duckweed (Lemna) often blankets the entire area. The floating-leafed pondweeds growing in shallow areas often form a dense bed like a collar around an entire pond.

For the purpose of finding a means to control or eradicate emergent aquatic plants whenever a species becomes obnoxious in a particular body of water, experiments were conducted. Several chemicals known to be lethal to terrestrial plants were used with techniques modified for the characters of the various aquatic plants.

Methods and Applications

The plant poison herein discussed is the chemical hormone recently developed by the Sherwin-Williams Company and known as Butyl Ester of 2,4 - Dichlorophenoxy Acetic Acid. This compound is distributed by many chemical companies as a 14 per cent active ingredient of butyl ester of 2,4 - dichlorophenoxy acetic acid with 86 per cent of inert ingredients, under various trade names registered by the different companies.

When certain species of plants are sprayed or wetted with a dilution of 2,4-D in water, the physiological reaction of

the plants seems to be one of intensely stimulated growth. This growth, possibly along with other reactions, is the cause of slow death to the plants. The most plausible explanation of the physiological reaction of plants to this chemical has been advanced by E. D. Witman, of the Sherwin-Williams project in the Ohio State University Research Foundation. In personal correspondence he states that:

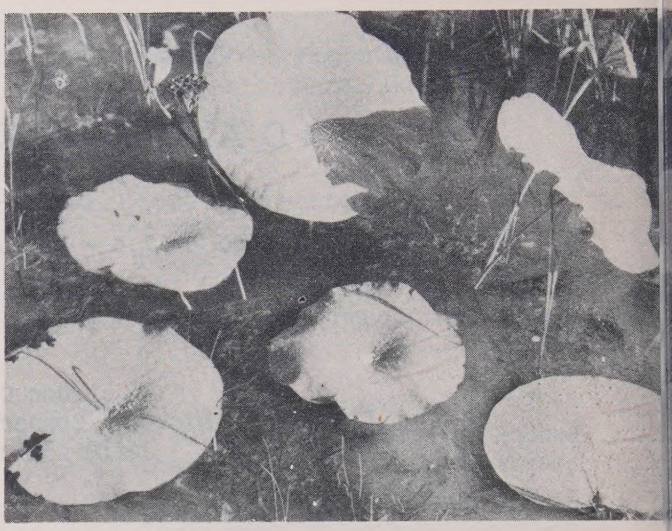
1. 2,4-D appears to be absorbed and translocated to all parts of the plant;

2. 2,4-D (a) upsets the osmotic systems in the plants, allowing free movement of water and water-soluble substances, (b) transforms stored carbohydrate (starch) into soluble sugars, and (c) prevents manufacture and storage of starch;

3. under these conditions the plant begins to respire and transpire at greatly accelerated rates, and soil bacteria and fungi begin attacking the subsoil parts, resulting in the death of the plant.

The 2,4-D diluted with water was applied in the form of a spray to the leaves of emergent aquatics. A very fine spray produced by high pressure speeds up the task and gives more uniform coverage. The fine droplets cling to the highly waxed surfaces of the leaves; whereas the weight of larger drops overcomes the adhesion to the leaf surface, causing the solution to run off the leaves. The behavior of a drop of water on the leaves of water lotus and similar plants is familiar to most people: the leaves, being unwettable, give the drop of water the appearance of a drop of mercury rolling about on a smooth surface.

Though 2,4-D itself acts weakly as a detergent or wetting agent when mixed with water, area coverage per unit volume of spray solution is greatly increased and the intensity of spray needed on a given area is decreased by the addition of another wetting agent. The detergent reduces the surface tension of the water drops and renders the waxed surface of the



Excessive spray of 2,4-D in water collects in spherical drops on leaves of water lotus.
(Photos by Mo. Cons. Dept.)

leaves more wettable, so that small drops flatten into wet spots with a low profile instead of standing as spheroids.

Of the several wetting agents tried, all those with a basic reaction were discarded because of a possible reaction with the 2,4-D. This reaction was suspected because of a noticeable change in odor or in color and appearance of the solution. The wetting agent used throughout the final tests was Vatsol OS, 66 percent paste, developed by the American Cyanamid and Chemical Corporation. This chemical is slightly acid to neutral and produces no apparent reaction with the spray solution. Although the addition of 1 part of Vatsol OS, 66 percent paste, to 10,000 parts of water conspicuously and satisfactorily reduced surface tension and increased the wetting power, the dilution used in the final tests was 1 part to 1,000-2,000 parts of water.

For small pools, ponds, and shoreline infestations of obnoxious weeds, the spray can be satisfactorily applied with a backpack sprayer from the bank, from a boat, or while wading. For large areas of solid stands, a boat equipped with a power-sprayer is more economical; in theory, application from the air on a grand scale with modified techniques is possible. When the spray is applied from a boat or while wading, the area covered should be beside or behind the operator because subsequent disturbance and immersion of the

Excessive spray of 2,4-D plus detergent completely wets leaves of water lotus, giving them a dark, glossy appearance.

leaves removes the spray. No attempt should be made to wet the leaves with the solution; coverage with a very thin spray is just as effective. Full coverage of a plant or the whole surface of large leaves is not necessary for a kill.

Solutions of 1 part of 14 percent active ingredient Butyl Ester of 2,4 - Dichlorophenoxy Acetic Acid, with 86 percent of inert ingredients, to 130-150 parts of water (with and without previous addition of Vatsol OS at the rate of 1 part to 1,000-2,000 parts of water) were applied under high pressure from hand-operated sprayers. The spray was directed toward the leaves of the plants from a distance close enough for coverage but not near enough to cause drops to form and be knocked off the leaves. In the case of lotus or spatterdock, an attempt was made to cover some parts of all visible leaves. In treating waterwillow or waterprimrose, the objective was only a general coverage of the bed.

The area covered by a given volume of spray solution varied with the species of plant, the density of growth, the succulence of the plant, the wind velocity, the humidity and temperature, the presence or absence of detergents, and the dilution of the 2,4-D. For cattails, which have erect leaves highly resistant to wetting, the coverage per gallon of 2,4-D in solution with water was approximately 200 square feet. For less resistant plants having horizontal and more wettable and delicate leaves, such as the waterprimrose, the coverage was as great as 500 to 600 square feet per gallon of solution.

Of the plants treated with the 2,4-D solution, cattail required the greatest concentration (1 part of 2,4-D to 130 parts of water) and was the slowest to react to the treatment. The plants quickest to react to the spray were waterprimrose and waterwillow; likewise, they required a lower concentration of 2,4-D for a kill, as sometimes 1 part of 2,4-D to 500 parts of water was effective. No attempt was made to ascertain the minimum dilutions of 2,4-D that would be effective in killing the species treated. However, varied applications have indicated that in some instances the strength of solutions might be further reduced.

A discussion of the plants treated, summarizing observations of conspicuous reactions to 2,4-D and the results (positive and negative), follows:

American Lotus, Nelumbo lutea Willd.

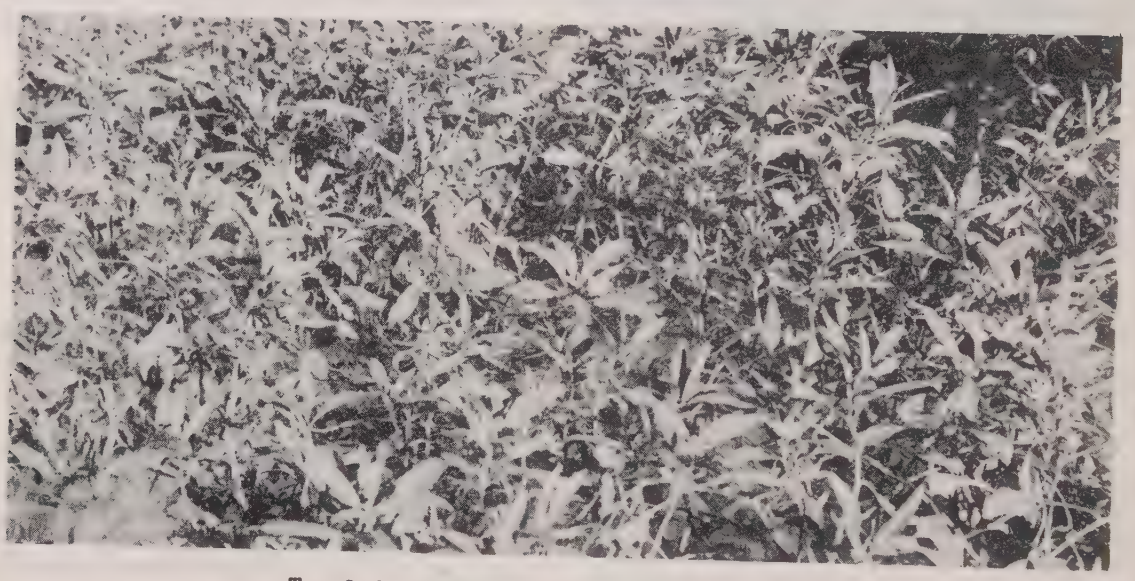
American lotus was killed by spraying with 1 part of 2,4-D to 150-300 parts of water (with and without vatsol). The plants were sprayed while in succulent stage of blooming and later when the seed pods had matured. Both floating and emergent leaves were treated. The reaction of the plant was slower and the effects were less apparent in the late-season application.

The addition of vatsol increased the area covered by a given amount of spray. The effect of vatsol was demonstrated by directing the force of spray against a plant. Wetting was so complete that the leaves became glossy and drooped. The same procedure without vatsol caused drops to form and run off the leaves.

Succulent plants showed a slight droop of the leaves within 1 hour after spraying. Two days later floating leaves became light yellow, and many of them were turned over by twisted petioles. The emergent leaves were mottled with irregular areas of green, yellow, and brown. Many petioles were spiraled, pig-tail fashion, and some of the leaves were arranged vertically on bowed petioles.

One week later the leaves were dead or

Early effects on mature water lotus.



Tangled growth of waterprimrose can be eradicated quickly with 2,4-D spray.

No deleterious effects visible on pondweed 60 days after spraying.

nearly so and immersed by the broken petioles. Decay began in the leaves and upper petioles and progressed downward, reaching the underwater stems in 10 days after application of the spray. At this time the young leaves, becoming emergent or floating at the end of much-spiraled petioles, were intensely crinkled, like lettuce.

Twenty-four days after the application of 2,4-D (with and without detergents) the leaves were decomposed; the petioles were rotted and broken; the nodes and roots, whether deep or shallow, were bluish-gray; the odor of decay resembled kraut or ensilage. Some internodes of the underground stems still had whitish areas interspersed with the bluish streaks of decay, but the whole had an odor of decomposition and the plants were considered dead. At the end of 75 days no revival of growth could be detected in the sprayed areas.

Waterwillow, Dianthera americana L.

This plant was sprayed with 1 part of 2,4-D to 130-250 parts of water when the bed was in full bloom. The areas sprayed with the solution that included a wetting agent showed a glossy wetness unlike those areas treated without the wetting agent. Within an hour the plants treated with 2,4-D plus a wetting agent looked slightly different, as though the leaves were set at a changed angle. Forty-eight hours later all the beds treated with 2,4-D had become completely prostrate, the stems all pointing the same direction as though beaten down by high wind or driving rain.

The plants never raised themselves from the horizontal. As time progressed, the leaves turned over and wilted and areas mottled in light yellow became evident. Next, the leaves and stems changed from yellow to brown, decay beginning in the upper parts. Twenty days after the treatment all visible parts were brown and dead, the underwater parts of stems and stolons were filled with a gray mold, and gray streaks showed in the white. An odor of decomposition was very noticeable. Within 30 days there was no aboveground evidence of the beds, and there were only traces of the almost completely decomposed underground parts. The result was the same for all areas treated with 2,4-D, whether or not it had been used with a wetting agent.

Cattail, Typha latifolia L.

Though cattail was treated with many and varied techniques of application, the method described here is that of spraying uncut plants with 1 part of 2,4-D to 130 parts of water (with and without a wetting agent). The plants were sprayed when in full bloom. Leaves of cattail were highly resistant to wetting; unless the finest spray obtainable was used, droplets formed and ran off the plant except when a wetting agent had been added. Use of a wetting agent gave the leaves a dark gloss.

The first symptom after treatment was a slight yellowing of the tips of the leaves. Fifteen days later, the plants sprayed with 2,4-D without a wetting agent still showed only a slight yellowing near the outer tips, but those on which a wetting agent had been used were yellowed completely. Twenty-five days later, among the plants described here, the former still showed green in the leaves, while the latter showed no signs of life above the ground. The leaves did not decay as in other species of plants; instead, cattail merely dried crisp, remaining erect. Dark streaks of decay were observed in the underground parts.

Between 25 and 30 days after treatment, cattle breached the area, consuming all accessible parts of the treated plants and leaving intact the untreated areas. This damage prevented further observations, so test plots were again set up and the mature plants with ripening "tails" were treated with 1 part of 2,4-D to 75 parts of water containing a detergent. These plants exhibited the symptoms described above, but their reaction was slower. Within 52 days after the application, all the abovewater parts of plants were dead and the underwater parts were streaked and darkened with decay. Sixty-five days after treatment, when all parts of the plants were dead or were being attacked with bluish mold or brown rot, the plants were considered dead.

Waterprimrose, Jussiaea diffusa Forsk.

Waterprimrose was treated with solutions of 1 part 2,4-D to 130-500 parts of

water. The use of a wetting agent increased the area covered but apparently made no difference in the effects of the poison.

Within a few minutes after application the leaves showed a slight wilt. Within an hour the entire treated area became lighter green in color and a slight drooping of the erect stems was noticeable. Thirty hours later all leaves were yellow and the formerly erect stems were prostrate. The vines extending on the water were limp and wet. Within 4 days the leaves were browning, stems were decaying, and the underwater parts showed streaks of rot. Within 10 days or 2 weeks all parts of the plants were dead and the underwater parts had rotted.

Caution is needed to effect a complete kill in one application: the terrestrial parts of the plant intermingle with shore vegetation, and long floating vines rooted far out may not be affected by the death of the parent plant. If seeds have been deposited the preceding year, another treatment is necessary when the seedlings appear.

Arrownead, Sagittaria latifolia Willd.

When these plants were treated with 2,4-D (with and without a wetting agent), they showed no effects until about the third day, when they tilted their leaves off the horizontal. From then on, the leaves yellowed rapidly, this color extending down the petioles; at the end of a week the petioles were prostrate and the leaves were decaying in the water. After 18 days all parts of the plants were dead and decayed.

When or at what stage of growth the 2,4-D was applied, seemed to make little difference in the end. Lethal effects were obtained by spraying even in the late fall just before frost. Young succulent plants, however, seemed to be more quickly affected than mature plants.

Pondweeds, Potamogeton americanus C. and S., and P. diversifolius Raf.

These two species were highly resistant to solutions containing 1 part of 2,4-D to 130 parts of water (with and without wetting agents). No effects were observed at any time, except that in the first 24 hours small brownish dots were found on the leaves where 2,4-D with wetting agent had collected. The edges of leaves protruding above the water were slightly curled, but this aspect disappeared 24 hours after spraying. The spray was applied before the seeds had matured, and no ill effects had appeared 3 months later.

Pickerelweed, Pontederia cordata L.

This weed, treated while in full bloom, was quite susceptible to 2,4-D (with and without a wetting agent). Reactions were noticed within 24 hours. Twisted petioles, turning the leaf blades on the vertical axis, were first noticed, followed by yellowing of the leaf. The yellow color extending down the petiole was followed by prostration of the plant. Underwater parts became streaked with rot within 10 days after the application.

Flood waters prevented observations for 3 weeks, but by then the plants had completely decayed. The exact period of time required to kill the plants was not ascertained.

Spatterdock, Nuphar advena Ait.

In the treatment of spatterdock with 2,4-D, a much greater coverage was obtained when a wetting agent was used. However, though the solution appeared to be in closer contact with the plants on the wetted areas, the effects of the poison were not visibly accelerated. The first symptom seemed to be a relaxation of the turgid leaves. No twisting of the petioles was observed, but within 24 hours nearly all the leaves were tilted off the horizontal plant. Yellowish blotches formed in the outer parts of the leaves within 48 hours and extended toward the attachments of the petioles. These areas later curled and dried brown as the yellowing progressed downward to the waterline, where decay set in while the petioles were yet green. At the end of 10 days the underwater parts of the plant were being attacked by rot and the petioles gave off the odor of decomposition.

Duckweed, Lemna minor L.

This plant was the most resistant of those treated. When the spray was applied

at too short a distance, the force tilted the plants, allowing the water on which the weeds floated to carry off the 2,4-D. Spray in very fine droplets seemed not to affect the plants.

When a wetting agent was employed with the spray, the wet surfaces of the plants made contact with the water on which they floated and the solution was pulled off, so that the plants quickly became dry. In areas where the correct amount of spray was applied with proper force, a conspicuous yellowing of the plants was detected within 24 hours. But, duckweed being quite mobile, such areas were soon intermingled with untreated plants as the water surface was disturbed. High concentrations, such as 1 part of 2,4-D to 75 parts of water, gave no satisfactory results.

Summary

Of the species of truly emergent plants treated with 1 part of 2,4-D to 130-500 parts of water, all were killed within 10 to 65 days.

The length of time necessary for killing varied with the species, the succulence of its growth, the weather, and in some instances the presence or absence of a wetting agent.

Water lotus was extremely susceptible to 2,4-D and, of the species treated, exhibited the most conspicuous reactions.

Of the two pondweeds with floating leaves, neither showed any ill effects. Duckweed also resisted treatments with 2,4-D.

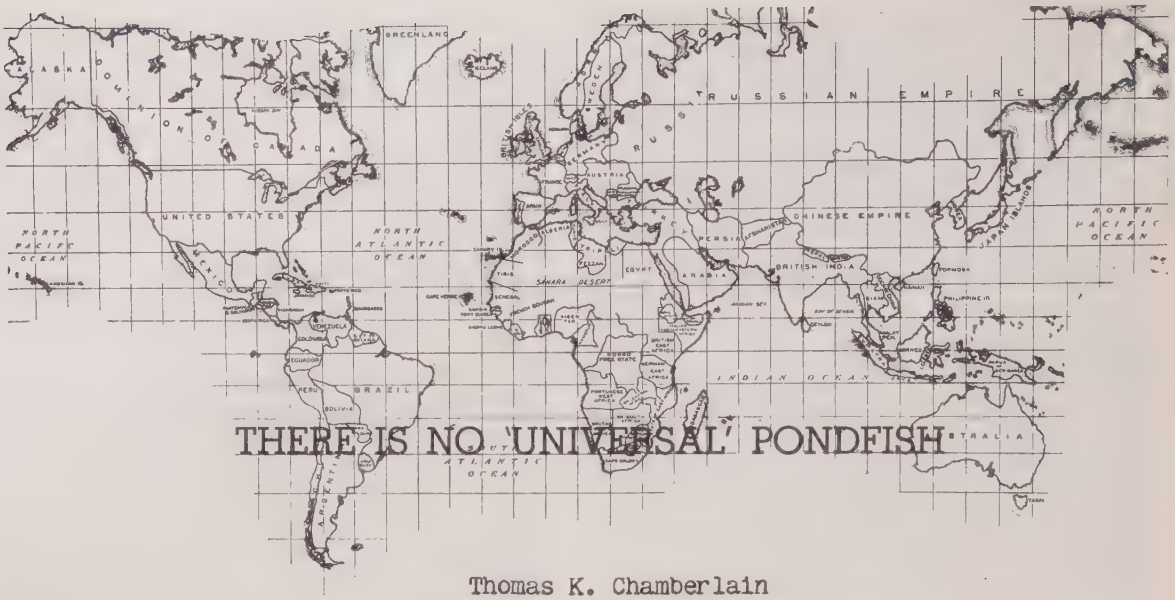
The area covered by a unit volume of spray varied with the species, the weather, the presence or absence of a wetting agent, the density and succulence of the growth, and the dilution of 2,4-D. The coverage by 1 ounce of 2,4-D to 1 gallon of water varied from 200 square feet (cattail) to 600 square feet (waterwillow).

No deleterious effects on fish or other animal life were observed. Though the poison was sprayed on large beds of waterprimrose that completely covered small ponds and extended entirely around a 7-acre and a 3-acre lake, no effects were noted on fish 5 months after application.

QUESTION DEPARTMENT

WHAT'S bothering you? What's your pet problem?

Many a participant in a radio quiz show has stalled and stuttered to no avail--and then heard the studio audience shout the correct answer. Maybe you're a little flustered by your own proximity to the "mike." Maybe you just need one friendly whisper. Maybe you have made all the wild guesses your time will permit. If you have a question, the Editors of the PROGRESSIVE FISH-CULTURIST will be glad to serve as Masters of Ceremonies. If, unfortunately, the right answer isn't already typed in capital letters on a small card to be palmed during the show, the Editors will promptly refer the question to someone in the world-wide audience of biologists and fish-culturists.



THERE IS NO 'UNIVERSAL' PONDFISH

Thomas K. Chamberlain
Fish and Wildlife Service
College Station, Texas

IN THE BEST eating place in the little Florida town where my headquarters have been located for several months, the menu tends to repeat itself. For dinner there are usually five choices if one reaches the counter early. With occasional modifications there are nearly always the following possibilities: vegetable plate, 50 cents; beef stew, 60 cents; chopped sirloin, 70 cents; baked ham, 80 cents; fish, 90 cents. This last item always intrigues me. No particular fish is mentioned. There is just one word, "fish." Yet, when it comes to prices, like the name of Abou ben Adhem, lo, it leads all the rest.

True, this is but a single instance. Perhaps, because I have had to face that menu so many times, I give it unmerited weight; but I do think it is suggestive of how the wind is blowing. As one who is interested in pondfish culture, I find myself continually speculating as to how this field of endeavor might reduce the cost of the fish item to the level of one of the meat fishes--perhaps not down to beef stew, but at least to that of the glorified hamburger, that is to say, the chopped sirloin.

Very, very slowly this country is becoming more fish conscious. Just study the menu in your own pet restaurant the next time you eat there. The chances are that fish will be one of the items any day of the week and that it will not be listed at the bottom. Also, in many parts of the country it is likely to be freshwater fish when this is available. In New Orleans, recently, I was told that fillets of channel catfish had been selling for as much as $1.19 a pound. Such a price places channel catfish in the luxury class. How many salt-water fishes ever command that price? But just try to buy some channel catfish these days! There are few areas where the supply can even begin to meet the demand. Also, you will find in our inland communities people who believe that there is no adequate substitute for the channel catfish, certainly that no salt-water fish can take its place. These people are ready, when necessary, to pay more for their favorite food fish than for others. If the freshwater commercial fisherman cannot meet the demand for this fish, the job would appear to be one for the fish-culturist.

The idea is not new, of course, but unquestionably fish-cultural thinking now is stronger in this general direction than ever before. Several States have research workers on the problem of fish as crops, to be raised by the farmer for the market as he might raise crops of turkeys or rabbits. The Fish and Wildlife Service has not yet announced any formal

program of research in this direction, but it is following all developments closely.

There is another factor. The various conservation agencies involved are a little weary of the farm pondfish balanced-population battles now on their hands. Probably the heart of the trouble is that at present very few farm ponds provide either revenue or food for the owners. Because the fish are merely a source of recreation for the pond owners, they invest as little time and money in their ponds as possible. It is a true saying that that which costs nothing is worth nothing. Vigilance may be the price of liberty: it is also the price of other things, including good farm-pond fishing. Vigilance, followed by prompt and vigorous action as may be necessary. Good fishing can be had from farm ponds that have been built right, but they also need care, and too few owners seem ready to give their ponds the necessary care. Once the pond owner decides that he can obtain revenue from his pond, it is likely that his attitude toward his pond will change.

Many people feel that fish as crops can pay only when the individual fish under consideration becomes a luxury item. For some time trout of several species, obviously in this luxury category, have been raised for a limited market. When catfish bring more than a dollar a pound, they may be considered to fall into the same class. But all luxury markets are limited and uncertain.

There is a second approach to the problem of making a profit from raising food fish in ponds for the market. Where low-cost fish food is available, the necessary profit may be made by the quantity production (per unit of pond-surface area) of fish bringing only a medium or low price on the market. This is the approach that has been favored by most other nations interested in pondfish culture. If the United States will adopt this approach now, our pondfish-cultural vision for the first time may be said to have become world-wide--not, as at the present time, limited by the boundaries of our own country. Foreign students in pondfish culture will find us working on problems that for the first time will have real significance for them. We shall then take world leadership in this fishery field as in so many others.

In the past, foreign students in pondfish culture who have come here to take home words of wisdom may have done so, but the words of wisdom have applied in large measure to our own domestic problems and interests. When applied to their conditions, our recommendations have sometimes given serious trouble. From Cuba, for example, have come expressions of regret that our black bass has been introduced there.

A particularly striking example comes from Mexico. Lake Patzcuaro is an isolated body of fresh water. A few years ago it seemed to have no fish population. The only animal that lived in it was the axolotl form of salamander, Bathysiredon dumerilli, a close relative of the tiger salamander found over much of the United States. B. dumerilli, however, has not been reported outside of Lake Patzcuaro. This salamander was used by the natives for food and was one of at least four species of salamanders that appeared in the fish market. Presumably through the influence of American farm-pond literature, black bass and sunfish were introduced into Lake Patzcuaro. The native salamander could not compete with the exotic and predaceous fish; instead, the salamander has disappeared from the lake, and this seems to mean that it has become extinct. Now the natives regret the exchange. They neither like the fish meat so well as the salamander meat nor obtain the poundage of fish meat that they did of salamander meat. But the error has been made and apparently can never be corrected.

The mistake of planting bass in this water is understandable. All our pondfish literature, Federal and State, praises the fish to the sky. The bass has been represented as the king of the warm-water pond. So it is--for the American pond owner who seeks recreation by fishing. But how many pounds of black bass meat as food can the owner get per surface acre of pond? Perhaps two or three hundred pounds per year.

Ask a Chinese fish-pond owner near Canton how many pounds of fish he gets from his own acre pond. If he says he is obtaining average production, that means that for each surface acre of his fish pond he is getting 3,990 pounds of fish meat per year. He will have reference to

five species of Cyprinidae, with which he stocks his pond according to some favorite of 11 recognized stocking formulae which include three to five of these species. With this formula the owner hopes to obtain the maximum weight of fish, every ounce of which (including heads and entrails) will be eaten. The pond owner will think of his fish entirely as a crop, a crop that he will feed all the cheap or refuse organic matter on which he can lay his hands, organic matter that he hopes at least one of the fish species will feed upon and turn into fish flesh.

A German, Polish, or Hungarian pond owner may tell you that for each surface acre of pond he expects to obtain more than 2 tons of carp, a fish that in those countries commands a price almost comparable to that of channel catfish in this country. The European pond owner also has to feed his fish to raise such a crop, but here again it is a case of feeding cheaper vegetable material in order to obtain higher-priced meat.

There is little question but that our farm-pond owners would make some real money if they knew how to raise 2 tons of channel catfish per acre of pond surface, even if the price of 1 ton went into feed and operations. Just how much assurance of success are we now in a position to offer an American pond owner if he is interested, as we know many are? Or is the channel catfish really the fish he should work with if he is interested in the market for the larger-growing fresh-water catfish? Perhaps he could do better with the yellow or flathead catfish, or maybe the white catfish, or the Pecos River catfish. Or maybe he and a few hundred associated pond owners might repeat the work of the European and Chinese pond owners and make as much money per unit of surface area by raising just carp, hundreds of tons of them. These associated owners might operate a cooperative fish cannery, where carp could be cooked under pressure cookers that softened the bones and where there might be added oils that would permit placing upon the market as acceptable and tasty a food product as that made from commercially taken carp in Minnesota during the war.

The story of the salamander of Lake Patzcuaro suggests that the future of pond culture may include more than the various fish species mentioned. Anyone who is familiar with the stock-watering ponds or "tanks" of our Southwest knows that even the most isolated pond soon has a population of fish or of the axolotl of the tiger salamander. To a limited extent, these axolotls are used as food by Mexicans and Indians. Apparently axolotl production per unit of pond-surface area is considerable, but we do not yet know what to do with this animal when we have it. Perhaps it would make good fish or dog food. Meantime, the American fish-culturist will do well to keep it in mind.

Recently a Chinese hydraulic engineer visiting in this country and interested in full utilization of proposed impounded waters in his country, inquired whether I did not consider it desirable that China introduce the largemouth black bass. He was obviously not convinced when I replied in the negative. He seemed sure that I was being facetious when I added that if tests ever showed that American aquatic fauna could be introduced to advantage in China, I believed salamanders, one or two species of fresh-water mollusks, and possibly a crustacean or two would probably be most useful. I said that if fish were introduced, the species would probably be one or more suckers, a group that would appear to fit into the Chinese picture, yet a group of which China has but one native representative. The engineer smiled politely, but it was evident that the question had been intended only as a courteous remark: he had the answer in the first place; for, as he stated, he had read our farm-pond publications and knew already that according to the best American thought on the subject the black bass and the bluegill sunfish were the species par excellence for warmer impounded fresh waters. If he had his way in the matter, modern China was going to have those fish species that Americans had scientifically determined to be the best.

Yes, other nations look to the United States for pondfish-culture leadership, more literally and perhaps more seriously than we realize. I am informed that the Office of Foreign Activities of the Fish and Wildlife Service is continually receiving requests for help along this line. To adjust ourselves to living consciously in a pondfish-cultural "One World," would require some re-evaluation of fishery

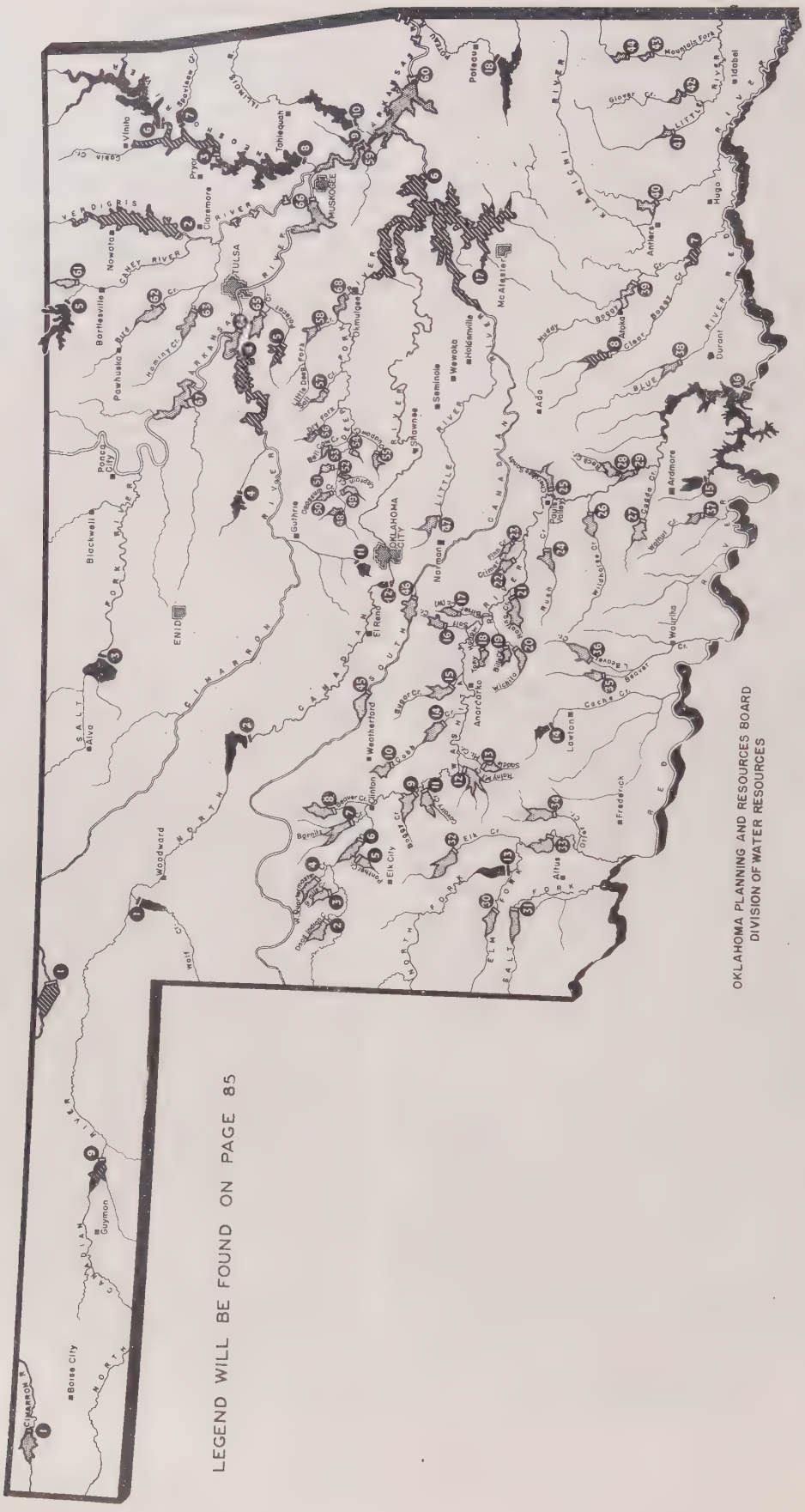
values and terms. Has the American interest in recreational fishing for pondfish anything in common with the European and Asiatic interest in pondfish as crops? If so, where can we get together? What "common denominator" can we find for our differing problems in pondfish culture? Research in this field may be greatly simplified if we can find definite answers to these questions.

Stepping from secure footing to uncertain and speculative ground, I wonder whether a start toward the answer might not be made if an "efficiency rating" could be worked out for each fish species of pond-culture interest, this rating to be based upon (among other things) ability of the species to turn available organic material into fish flesh. This might give one yardstick for comparison of species. For example, from Dr. H. F. Prytherch's preliminary work with mullet at Fisheries Laboratory, Beaufort, North Carolina, it would appear that the mullet could be given a high rating. Let us say 80 per cent on this particular basis of grading, as, according to Dr. Prytherch, the amount of mullet that can be raised on a unit of pond area is several times the best figure given by Mr. H. S. Swingle (Agricultural Experiment Station, Alabama Polytechnic Institute, Auburn, Alabama) for the "All-American fish team," black bass and bluegills. Carp and certain suckers might rate at 40, as their omnivorous feeding habits and ability to digest a wide variety of foods put them well above a predaceous fish like the black bass with its more limited food tastes. It is uncertain that the black bass could earn an efficiency rating of more than 10. For warm-water game-fish purposes, of course, we would still call for the black bass. On the other hand, even those species having marked ability to produce considerable poundage of fish meat per unit area would have to be considered further for flavor of meat, market demand, availability of stock fish, and costs of available food for growth. Still, other factors being equal, a crop of fish "A" at 20 cents a pound would outvalue a crop of fish "B" at 40 cents a pound if, for a given overhead, three times the poundage of "A" could be raised in the place of "B".

In helping foreign countries to improve their pondfish-culture practices, a yardstick of this sort would be invaluable in the preliminary studies of the relative merits of native fish species. It would mean experimental fish hatcheries to be built where the work could be done, but the determinations should establish the position of these species in relation to all foreign and American species previously studied. It should then be possible to advise a government that, because its species were substandard, it should introduce exotic species for the ponds of particular areas, that certain previously studied foreign species appeared most promising, and where these might be found.

This foreign use of the yardstick does arrest the attention first, but its value would be in its universal application. It would place all pondfish culture in one understandable pattern. This might be the carp culture of Poland, the eel culture of Denmark, the tench culture of Italy, even the milkfish culture of the Philippines and the mullet culture of Hawaii. Also, there could be determined the theoretical place of potentially important cultures of one aquatic form or another, such as the axolotl of the tiger salamander, or Mexican, Central or South American species of the Cichlidae (including our unpopular Rio Grande perch, which offers such promising pond-culture possibilities).

Yes, if someone can work out some such yardstick, it will prove very useful. But whether or not this is done, let no pondfish-culturist forget that we now live in a "One World" relationship to each other and this includes our own field of activity. When you put in writing some glowing tribute to a particular fish, just bear in mind that your enthusiasm may be contagious. That may be fine or it may be embarrassing if your enthusiasm is unbounded. I plan a fishing expedition all over the world when I retire. If I pull out black bass, each followed by exactly 10 or 15 sunfish, from every fresh water in every nation where I cast my line, I am going to be annoyed.


OKLAHOMA PLANNING AND RESOURCES BOARD
DIVISION OF WATER RESOURCES
LEGEND WILL BE FOUND ON PAGE 85

FISHERY MANAGEMENT IN OKLAHOMA

IMPOUNDMENTS UTILIZED TO THE ADVANTAGE OF FISHERY-MANAGEMENT STUDIES

A. D. Aldrich
Director, Fisheries Division
State Game and Fish Commission
Oklahoma City, Oklahoma

MUCH WATER has been impounded in Oklahoma since publication of the PROGRESSIVE FISH-CULTURIST was suspended in 1941. The farm-pond program of the Soil Conservation Service and the reservoirs--flood-control, hydroelectric, irrigation, and recreational--constructed by the U. S. Corps of Engineers and the Bureau of Reclamation have transformed Oklahoma from a semiarid region into a land of sparkling waters. Farm ponds of every conceivable size and type number well over a hundred thousand. Five multiple-purpose reservoirs ranging in size from 1,600 to 96,000 surface acres have been completed. Four major impoundments are now under construction, a dozen more have been approved for construction, and dozens are in various stages of planning and survey.

To say that this deluge of impoundments has set the stage for an extensive program of fishery-management studies, is putting it mildly. From pre-impoundment preparation of new lakes to drainage and rehabilitation of old ones, every type of opportunity is now available for a complete follow-up on stocking and management practices. The opportunity is so great and the biological sciences involved are so diversified that the Game and Fish Commission has enlisted the aid of the technicians and planning personnel of the various agencies concerned and the professorial staffs of the State university and colleges. Ours is largely a function of coordinating the planning and operational activities of the various organizations. Personnel of the Game and Fish Commission have worked very closely with personnel of other agencies on phases of fish and game management, and the relationship and cooperation have been most satisfactory. Perhaps a discussion of some of the procedures employed or planned will assist others in their approach to fishery management in newly impounded waters. Suggestions and aid are solicited from all sources; all phases of developments will be reported from time to time.

The Oklahoma Game and Fish Commission honors applications for stocking farm ponds or private lakes. Eleven hundred applications are on file for this year. The State is divided into districts, one for each of the six State hatcheries. The applications are recorded in the central office and forwarded to the hatchery superintendent in whose district the waters to be stocked are located. Then

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Oklahoma is one of the States directly affected by the program of river developments. The State has offered splendid cooperation throughout the undertaking. Mr. Aldrich's description of the Game and Fish Commission's activities indicates that it has been fully aware of the opportunities for a better fishery program. We suggest that information of a similar nature from other States would be very interesting.

See also:

Dieffenbach, R.
1947. River developments and their effects on fish and wildlife resources. Prog. Fish-Cult. 9 (1): 9-12.

the hatchery superintendent inspects the waters and makes his recommendations for the stocking and management of the pond. Applicants may request any species, but the recommendations of the inspector are used as a basis for allotment of numbers and species. This system is very effective in that it gives the hatcherymen first-hand information regarding effectual disposition of their product and enables them to plan efficient distribution routes and to become acquainted with interested sportsmen and conservation leaders of the State. The hatcherymen's permanent files on fish distribution and stocking techniques supply valuable data for follow-up work by our research staff.

Our Commission has a very effective agreement with the Fish and Wildlife Service for exchange of stocking records. All applications to the Federal agency for fish to be placed in private waters in Oklahoma are checked through this office to avoid duplication of stocking. A monthly report of fish distributed in Oklahoma by the Fish and Wildlife Service is received for our files. We are deeply appreciative of the cooperation between our respective agencies.

This, in brief, is the manner in which the farm ponds of the State are processed and managed. Of course, public waters are stocked without application. Distribution of fish to streams is based on the recommendations of the biological section and the hatchery superintendents of the various districts. Stream surveys to determine the existing fish populations and future management policies are being planned under the direction of the technical staff in cooperation with the professors and students of the State colleges that offer wildlife-conservation courses.

The Oklahoma Game and Fish Commission has established a very effective, very agreeable relationship with the U. S. Corps of Engineers and the River Basin Studies staff of the Fish and Wildlife Service. When reservoirs are approved for construction by the Corps of Engineers, all the pertinent data, including contour maps of the area, are forwarded to this office for study and recommendations concerning fish and game management. These studies include field surveys made jointly by our staff and representatives of the Corps of Engineers and the Fish and Wildlife Service. Our recommendations concerning pool elevations, pre-impoundment preparation of the basin for its future management, establishment of study stations, construction of brush shelters, clearing of the area, and land-use policies are all incorporated in the preliminary survey reports and the over-all plan for construction and operation of the projects. Without the cooperation of all agencies involved, the wildlife potentials of these large areas could not be given proper attention.

Regulation and management of fishing in all these reservoirs after impoundment are responsibilities of the State. In order to secure data on all phases of biological successions of impounded waters, the Game and Fish Commission has enlisted the aid and cooperation of the Oklahoma A. and M. College and the University of Oklahoma. Plans are being made to construct facilities at these institutions for cooperative studies and fishery investigations. Whenever possible, graduate students will be employed to work on specific problems under the joint direction of the staff of the Game and Fish Commission and the colleges. It is believed that such cooperation will be of immense value to this Commission and to the schools, as at this time Oklahoma A. and M. College has 31 students enrolled in wildlife-conservation courses.

The technical personnel of the Commission are conducting studies of species composition, age groups, growth rate, stratification of the waters, and movements of fishes in the large reservoirs of Oklahoma. It is planned to station a technician permanently at each major reservoir area to secure data on all phases of fishery biology from the time of impoundment. Data collected on existing reservoirs are used as a basis for stocking and management practices recommended for new impoundments. The follow-up during the succeeding years should produce evidence of the effectiveness of various techniques and practices.

Since there have come into existence in Oklahoma so many new lakes that provide year-round angling, many owners of old lakes and ponds have become interested in draining and restocking their waters.

The Fisheries Division supervises the draining and collects data on fish yields and stocking and management practices employed on small lakes and farm ponds. Activities of this nature are a valuable source of biological information and are practical demonstrations on the results of stocking ratios. Hatchery personnel and equipment are used during this pond-drainage work, which provides invaluable information concerning the results of their propagation and distribution efforts. We plan to do considerable work of this nature in cooperation with individuals and clubs. Such activity rounds out the experience and knowledge of the hatchery personnel, enabling them to make inspections of ponds and deliveries of fish on the basis of proved results.

The fishery program in Oklahoma is expected to utilize the facilities and staffs of the State educational institutions and to coordinate with the plans and policies of the Game and Fish Commission the work of the technicians of the various agencies concerned with construction of projects. We believe this coordination of effort and the close relationship of personnel attached to the various agencies are the most important phase of the program. Everyone is included in the objective: each--the engineer, the contractor, the biologist, and the fish-culturist--contributes his share toward what we hope is a unified effort to provide more angling and shorter intervals between bites.

RESERVOIR PROJECTS

EXISTING OR UNDER CONSTRUCTION

1.	Fort Supply Reservoir	$ 7,450,000
2.	Canton Reservoir	9,205,000
3.	Great Salt Plains Reservoir	4,506,000
4.	Lake Carl Blackwell	369,960
5.	Hulah Reservoir	8,600,000
6.	Pensacola	25,000,000
7.	Spavinaw	
8.	Ft. Gibson	32,950,000
9.	Greenleaf Lake	249,506
10.	Tenkiller Ferry	13,425,000
11.	Upper Bluff Creek	7,163,000
12.	Overholser	
13.	Lugert Altus	3,627,000
14.	Lake Lawtonka	
15.	Lake Murray	2,500,000
16.	Denison	59,315,000
17.	Lake McAlester	
18.	Wister	8,090,000
		$182,450 466

AUTHORIZED AND APPROVED

1.	Englewood Reservoir	o,684,000
2.	Oologah	13,700,000
3.	Markham Ferry	24,150,000
4.	Mannford Reservoir	17,635,000
5.	Heyburn Reservoir	1,709,000
6.	Eufaula	54,395,000
7.	Boswell Dam	9,400,000
8.	Tupel	2,500,000
9.	Optima	10,284,000
		$140,457,000

RECOMMENDED

1	Kenton	3,785,000
2.	Dead Indian Creek	650,000
3.	Nine Mile Creek	450,000
4.	West Quartermaster Creek	665,000
5.	Panther Creek	255,000
6.	Foss	6,925,000
7.	Barnitz	1,000,000
8.	Beaver Creek	260,000
9.	Bessie Lower	750,000
10.	Cobb Upper	280,000
11.	Cavalry Lower	1,200,000
12.	Rainy Mt.	1,100,000
13.	Saddle Mt.	560,000
14.	Cobb Lower	1,100,000
15.	Sugar Creek	1,100,000
16.	Salt Creek	240,000
17.	West Bitter Creek	600,000
18.	Tony Hollow	166,000
19.	Bills Creek	145,000
20.	Little Wichita	625,000
21.	Roaring Creek	400,000
22.	Crimer Creek	470,000
23.	Finn Creek	300,000
24.	Rush Creek	2,494,000
25.	Cherokee Sandy	1,000,000
26.	Wildhorse Creek	1,500,000
27.	Caddo Upper	770,000
28.	Rock Creek	900,000
29.	Dougherty	
30.	Mangum (Elm Fork)	
31.	Mangum Lower	2,000,000
32.	Sentinel Elk Creek	
33.	Navajo	5,200,000
34.	Mt. Park (Otter Creek)	1,400,000
35.	West Beaver	1,400,000
36.	East Beaver	775,000
37	Walnut	
38.	Sandy Creek	2,100,000
39.	McGee	4,200,000
40.	Antlers	6,600,000
41.	Pine Creek	9,810,000
42.	Wright City	2,600,000
43.	Oxlow	13,000,000
44.	Narrows	14,613,000
45.	Bridgeport	
46.	Mustang	
47.	Norman	
48.	Coon Creek	
49.	Wildhorse Creek	
50.	Opossum Creek	
51.	Eagle Creek	
52.	Captain Creek	
53.	Bell Cow Creek	
54.	Kickapoo Creek	
55.	Quapaw	
56.	Dry Fork	50,000
57.	Salt Creek	
58.	Slick	
59.	Webber Falls	26,118,000
60.	Short Mt. Reservoir	40,083,000
61.	Copan	
62.	Avant	
63.	Skiatook	
64.	Keystone	45,000,000
65.	Rock Creek	
66.	Taft Reservoir	19,044,000
67.	Blackburn Reservoir	14,267,000
68.	Okmulgee	4,000,000
		$241,940,000

PROPOSED LOCKS AND DAMS

See map facing page 83.

GROWTH RATE AND FIN REGENERATION IN TROUT

J. H. Wales
Division of Fish and Game
Mt. Shasta, California

INVESTIGATIONS being conducted in Castle Lake, Siskiyou County, California, made apparent the need for information on the comparative growth rates for rainbow, brown, and brook trout kept under identical conditions. Further, most of the fish used in the Castle Lake experiments were marked by removal of fins, and, because some question had arisen about regeneration in these appendages, it was necessary to obtain some data on fin regeneration in these three species.

On August 6, 1942, 800 fingerling trout were marked (Table 1) by removing fins. These fish were placed in a 16- by 4- by 4-foot tank at the Mt. Shasta experimental hatchery. The tank contained about 192 cubic feet of water. The inflowing water amounted to about 30 gallons per minute; the temperature ranged from about 40° to 53°F., averaging approximately 47°. Once a day the fish were fed all they could eat. The food varied but was mostly beef liver and ocean fish.

On August 17, 1943, the surviving 643 fish were removed and measured from snout to the next half centimeter beyond the caudal fork. In recording the extent of fin regeneration, four arbitrary divisions were made: (a) no regeneration; (b) slight regeneration, signifying fin stubs which are just appreciable; (c) moderate regeneration, signifying fins approximately half the normal length; (d) much regeneration, signifying fins of approximately normal length but usually abnormal in number and shape of the rays.

Four groups of rainbow were used, all from eggs spawned at Mt. Shasta from the Mt. Shasta hatchery brood stock. Some of

TABLE 1.--Groups of fish marked and observed

Group	Number of fish 8/6/42	Number of fish 8/17/43	Average length 8/6/42 (centimeters)	Average length 8/17/43 (centimeters)	Average weight 8/6/42 (ounces)	Average weight 8/17/43 (ounces)	Fin mark*
Rainbow (Mt. Shasta)	100	90	5.5	15.4	.071	1.45	RV
Rainbow (Mt. Shasta)	100	84		14.9			RP
Rainbow (Burney)	100	92	7.0	19.0	.125	2.00	LV
Rainbow (Burney)	98	82		16.2			LP
Brook	100	94	5.5	14.8	.071	1.45	RV
Brook	100	69		15.8			RP
Brown	100	72	5.5	12.1	.067	.85	RV
Brown	100	60		12.9			RP

*R refers to right, L to left, P to pectoral, and V to ventral.

these eggs were hatched and reared at the Burney Creek hatchery in northern California and then brought back to Mt. Shasta for the tests. The fish reared at Mt. Shasta were troubled in some degree by a diet deficiency, although the groups used in these tests had been fed ocean fish and liver and were relatively free from the disorder (Wales, 1944). Because it was thought that the rainbow reared at the Burney Creek hatchery might have been less troubled by the diet deficiency, these were used for comparison. Because of a higher average water temperature at the Burney Creek station, the Burney fish were larger than the Mt. Shasta fish at the beginning of these tests. The rainbow trout used in these tests were from a fast-growing, fall-spawning stock. The brown trout were of the unselected Mt. Shasta hatchery brood stock. This stock had been inbred for about 40 years, and its resistance to disease appeared to be unusually high. In other respects these fish seemed perfectly normal. The brook trout were from a semiwild, unselected stock.

Table 1 indicates that under the conditions of the experiment there was no significant difference in growth between the groups marked by removal of a pectoral fin and those marked by removal of a ventral fin. Apparently there was a significant difference in mortality: much greater losses occurred in the groups without a pectoral fin. During the experimental period of a little more than a year, less than 10 dead fish were removed from the tank. Cannibalism is the only explanation that can be offered at this time.

Figure 1 shows the frequency distribution of "fork" length of fish at the end of the experiment. The purpose of this graph is to indicate differences in the lengths of the individuals of the four groups. It will be noted that the range of variation is considerably greater among rainbow trout than among brown or brook trout.

The results of this study of the growth rates of these three species should be viewed with caution. In a natural body of water the three species would choose different foods; in the hatchery tank the three species had to eat the same foods or none. This may have had some effect upon the results, but the Castle Lake data show growth speeds which are relatively the same as in the tank experiment.

It should also be remembered that the difference in growth rate may be due to strain as well as species differences. This possibility will have little bearing upon the application of the tests to the Castle Lake investigations, but other workers may find that the comparative growth rates for these three species are not quite the same when other strains are used.

The extent of fin regeneration may also be due in part to strain differences. In Figure 2, the fin-regeneration data taken from the Mt. Shasta and Burney groups of rainbow were combined because there was no difference in the extent of regeneration. This is important because fish in one group, at time of marking, averaged 0.125 ounce (8 per ounce) and in the other averaged 0.071 ounce (14 per ounce). Apparently in this size range the smaller fish can be marked as effectively as the larger. It must not be inferred, however, that much smaller trout, for example, 35 per ounce, can be marked as effectively as trout averaging 8 per ounce. Figure 2 shows the similarity between the rainbow and brown in regard to the regeneration of the clipped fins; in neither of these species was there much regeneration; on the other hand, nearly two thirds of the brook trout showed more or less regeneration. This point, if confirmed by subsequent work, may be of interest to both the fishery investigator and the physiologist.

The lower survival among fish marked by removal of a pectoral fin should be investigated further with large numbers of liberated fish. One naturally suspects that the fish without pectoral fins were more easily captured and eaten by the other fish in the experimental tank, but this may not be the true picture.

Conclusions

1. Under the conditions of this experiment the growth rates of the rainbow and brook were very similar. The brown trout grew much more slowly than the other two.

2. There was much less individual variation in growth rate of the brook

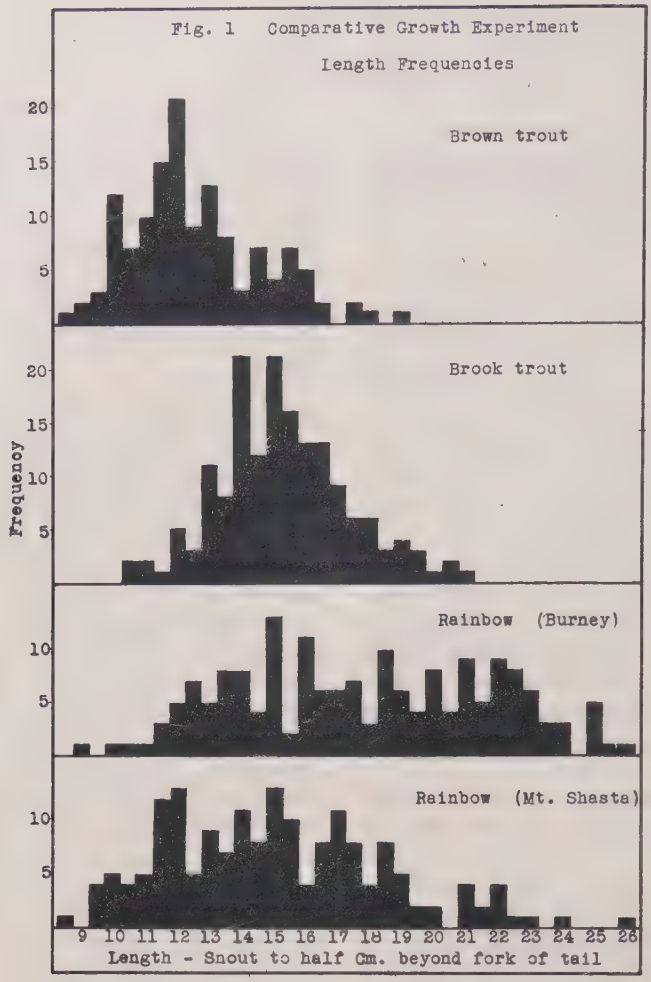
Fig. 1 Comparative Growth Experiment
Length Frequencies
Brown trout
Brook trout
Rainbow (Burney)
Rainbow (Mt. Shasta)
Frequency
20
15
10
5
9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
Length - Snout to half Cm. beyond fork of tail

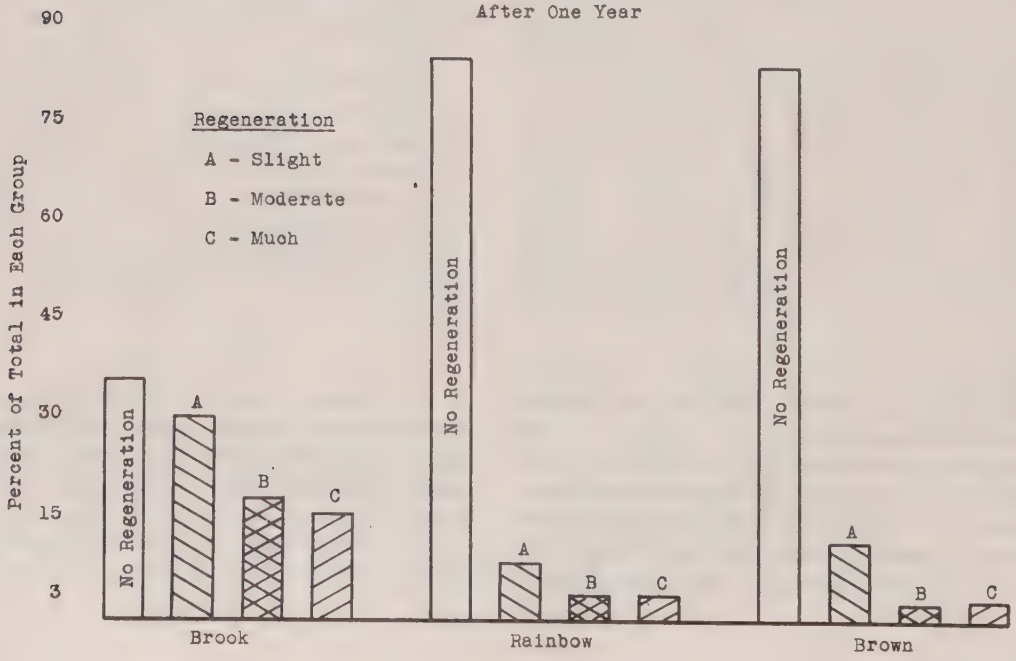
Fig. 2 Extent of Regeneration in Clipped Fins
After One Year
Percent of Total in Each Group
90
75
60
45
30
15
3
Regeneration
A - Slight
B - Moderate
C - Much
No Regeneration
A
B
C
Brook
Rainbow
Brown

and brown. This seems to indicate that the rainbow's heredity is the more heterogeneous. Some of the rainbow trout grew faster than any of the brook. This may mean that in the rainbow there is a greater growth potential, which, if developed by selection, would result in a faster-growing fish than this strain of brook trout. It must be pointed out, however, that these growth differences may be characteristics of the strains of fish as well as of the species.

3. These data do not show a consistent difference in the growth rate of those fish marked by removal of the ventral and those marked by removal of the pectoral fin.

4. There does seem to be a considerably better survival among those marked by removal of a ventral fin than among those marked by removal of a pectoral. This indicates that in experiments involving marked fish the pectoral mark should be avoided or those fish marked by removal of a pectoral should not be compared directly with those marked by removal of a ventral. This point should have further study with larger numbers of liberated fish.

5. Approximately two-thirds of the brook trout showed some fin regeneration, and the regeneration in about one-sixth of the specimens was sufficient to result in possible confusion with normal fins. In marked contrast with this, the amount of regeneration in both rainbow and brown trout was negligible. Apparently these brook trout have greater regenerative power than the rainbow and brown. Heacox (1942) found partial fin regeneration in brown trout marked by removal of the ventrals, but almost none of his fish had ventral fins regenerated to an extent that would cause confusion in later checking. The tests reported by Heacox were for periods of about 5 months, which may not have been long enough to bring out all the possible regeneration.

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1944. Fresh ocean fish as a trout diet. Calif. Fish and Game 30 (1): 43-48.

THE PROGRESSIVE FISH-CULTURIST

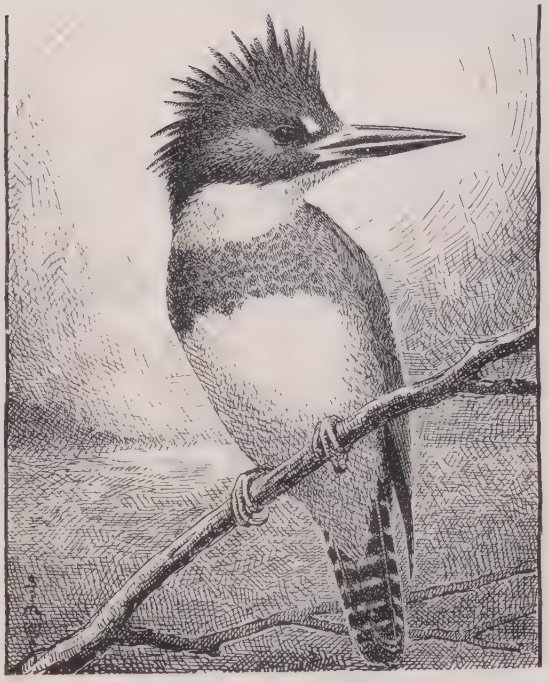
We regret that we are unable to furnish complete sets of the back issues of the PROGRESSIVE FISH-CULTURIST. Only a few copies of certain issues are still available for distribution. As long as the very limited supply lasts, we shall be glad to fill requests for No.'s 2, 7, 8, 13, 40, 54, 55, and 56.

Fish were made out of ignorant and senseless beings who had committed all sorts of sins and because of this they were not permitted to breathe pure air but were thrust down into the waters where they had to breathe in a deep and muddy medium--and hence arose the races of fishes and oysters which received the lowest habitation as a punishment for their extreme ignorance.--Plato.

Put That Shotgun Down!

ONE FISH-CULTURIST'S ESTIMATE OF THE KINGFISHER

Charles L. Fuqua
Fish and Wildlife Service
Albuquerque, New Mexico



THE AVERAGE fish-culturist assumes that fish-eating birds, kingfishers in particular, should be treated as bandits and shot on sight. Of the fish-eating birds, the kingfisher is probably the most persistent and causes the most trouble for the fish-culturist, especially the trout-culturist. However, taking a broader view than that of a protector of fingerling fish, one finds that this bird is of considerable interest to many lovers of wildlife, including fishermen.

Anglers who fish the swift and rocky streams or quiet farm ponds are familiar with the loud, rattling cry of the kingfisher as it goes its solitary way in pursuit of fish. This peculiar rattle attracts the attention of the city dweller on the streams for a Sunday outing, as well as that of the more experienced outdoorsman who has long been aware that the slatey-blue bird with ragged crest is a striking and pleasant addition to the landscape. These people realize that without the kingfisher, the mountain trout stream, the farm fish pond, and the shores of our larger lakes would lose much of their charm. To many people interested in the outdoors, the kingfisher's rather weird call has a meaning altogether different from its significance at a fish hatchery, where the sound is usually the signal to reach for the shotgun.

The Belted Kingfisher (Megaceryle alcyon) is found over nearly all of North America. It is essentially a fish-eating bird and is found on large and small waters that contain fish. It is a hardy bird and apparently remains in northern areas until the waters freeze over. For the most part, during the winter it migrates south, where the waters are open and fishing is easier.

The kingfisher has few natural enemies. Hawks apparently are the greatest winged enemy. Skunks and minks are probably the most active land enemies except man; these two animals, being able to crawl into the nesting holes, destroy the eggs and young. Bent (1940) contends that "the most serious enemies of the kingfisher are the selfish fisherman, who wants all the fish

for himself and begrudges the poor bird an honest living, and the proprietor of a trout hatchery, who is unwilling to go to the trouble and expense of screening his pools to protect his fish."

The bird is rather prolific, hatching as many as a dozen young in a burrow that has been excavated by the birds themselves in a sandy, clay, or gravelly bank. Six to eight eggs are most commonly found in a nest.

It is not the purpose of this article to give the kingfisher a "clean bill of health"; let us remember, however, that there are some good qualities in all birds. The all-important charge against the kingfisher concerns its food habits. The bird is a fisheater and is considered an expert angler. In 1930 Kalmbach reported that under natural conditions nearly three-fourths of the diet of kingfishers consisted of fish, and 23 percent of the whole was definitely identified as edible fish. Lumley (1935) stated that the Biological Survey studies showed that of food taken by kingfishers under natural conditions, about two-fifths consisted of fishes valued by man; about one-third of the diet consisted of nonedible fishes (most of which are spawneaters); one-sixth of the food consisted of crawfishes; and the remainder included frogs, dragonfly nymphs, diving beetles, and water bugs, all of which prey upon fishes. Cottam and Uhler (1936) reported that examination of 313 stomachs, taken in widely different sections of the country, showed that less than one-half of the fish were of edible varieties. Kingfishers will take fish in preference to other foods, and they would probably live on fish exclusively if in a position to do so. However, with the exception of those living adjacent to a fish hatchery, they are forced to find other sources of food. Most of the fish taken from the streams and lakes are species such as chubs, dace, and suckers, which are of little or no value to the angler and often are harmful to the sport fish. In such instances, the kingfisher, by reducing the number of these rough fishes, is of some benefit to the angler.

In 1930 Kalmbach reported that in 151 kingfisher stomachs secured at hatcheries in 11 different States, fish made up 84 percent of the content. A little less than three-fourths of this material was definitely identified as edible fish, mainly trout. His investigation showed that about two-thirds of the food of these birds was derived from the stock in hatchery ponds. One specimen taken at the Bozeman, Montana, station had eaten 32 small trout. The 14 highest records for fish consumption by kingfishers at hatcheries, as recorded by Kalmbach, showed stomach contents ranging from 11 to 35 trout. As the digestion of the kingfisher is quite rapid, a single bird could well eat a large number of trout fingerlings in one day if they were readily accessible. In his study of the food in these 151 stomachs, Kalmbach found that 20 contained crawfish, which, being spawneaters and causing damage to pond embankments, are a source of trouble to hatcheries. In the stomachs were also found predaceous diving beetles and frogs, both of which are harmful to hatchery fish.

Although the bird is generally considered less of a problem at the pondfish hatcheries than at the trout hatcheries, Superintendent Fred L. Cox of the Service's Mammoth, Arkansas, station has reported the removal of 48 No. 1 bass fingerlings from the stomach of one bird.

Superintendent Lloyd T. Pullum of the Saratoga, Wyoming, station mentioned an interesting side light on the predatory actions of the kingfisher, indicating that even as the human angler does not catch a fish on every cast, so the kingfisher is not successful at every try. Pullum, observing a single bird taking fish from a trout-rearing pond, found that the bird made 13 dives into the pond before catching a fish. Others have expressed the opinion that, although the kingfisher has an enviable reputation as a fisherman, it frequently comes up without a fish. Possibly we should discount somewhat its apparently industrious efforts to take fish.

It certainly seems that the fish-culturist should look upon this bird with an open mind inasmuch as evidence does not show the harm to be so serious as one might expect after viewing its activities at fish hatcheries. Most of the diet of kingfishers found on the fishing waters is made up of nonedible fish--fish that are, to a great extent, enemies of the sport fish. At the fish-cultural stations

it has been found that these birds do not live entirely upon the hatchery stock of fingerlings: here, as when over open waters, they feed upon organisms that interfere with hatchery operation. Anglers are prone to attribute poor fishing to some cause other than the more common ones of unsuitable habitat and overfishing. Thus fish-eating birds, such as the kingfisher, are often the "scapegoat" and their extermination is demanded.

That the kingfisher does some damage to our fish populations cannot be denied; that this damage is overemphasized by some fishermen is equally true.

I wish to avoid giving the impression that the losses from fish-eating birds at hatcheries are not fully recognized. I have seen too many ponds of sunfish fry cleaned out by ducks (and not necessarily mergansers), brood stocks injured and killed by herons, and fingerling trout going down the gullet of kingfishers.

In the preparation of construction plans, fish hatcheries--Federal, State, and private--have largely ignored the problem of protection. Why, when preparing plans for ponds for the rearing of small fish, do we not consider provisions for protection against fish-eating birds an integral part of the plans and costs? We provide for suitable valves, kettles, shade, and the like, so why not provide for protection?

In trout hatcheries, only the ponds holding the smaller fish (up to 5 or 6 inches) need be protected. At pondfish hatcheries, small fish usually are held in concentrated numbers in a very few ponds. These could be provided with suitable protection--which would cost money, of course, but not an excessive amount. If we fish-culturists can ever arrive at a state of mind whereby we consider protection from fish-eating birds a legitimate and necessary part of fish-pond construction, we shall give such an expenditure no more thought than that involved in the cost of the pond kettle. It does seem rather unbusinesslike to spend money to perpetuate and protect species of birds and, at the same time, refuse to make expenditures that will prevent the killing of these same birds.

The most effective protection against the kingfisher and all other birds is the poultry-wire enclosure. The wood or metal framework of such an enclosure can readily be installed around rearing ponds, especially the raceway type. If constructed of sufficient height and width to allow walking within, and with entrances of sufficient width, the enclosure will in no way handicap the operation of the ponds. This type of protection is in use at a number of hatcheries, although all too few, and allows complete peace of mind to the fish-culturist responsible for the care of the fingerling fish held in the enclosure. The vigilance that would otherwise be required on his part throughout the daylight hours is completely eliminated.

It has been noted that posts have been installed near some hatchery ponds for the purpose of trapping kingfishers. When the traps are not set, such posts provide perches and actual assistance in predatory activities, as the birds use the posts as places from which to dive and seize fish. If a wire enclosure cannot be installed, all possible perches in the vicinity of the ponds should be removed and those that must remain should be made as nearly unusable as possible. Cottam and Uhler (1936) suggested that posts be covered with small boards through which several long nails had been driven, the sharp points projecting upwards about 3 inches. The trapping of kingfishes from posts by use of small steel traps is cruel, and, as the traps do not differentiate between species, song and insectivorous birds are also caught. If shooting is necessary, it should be carried on only until efficient screening installations can be made, and only those birds that are actually raiding the fish ponds should be killed. Shooting, of course, is only a temporary expedient, for when one group is thus removed, another will soon move in.

Edward R. Hewitt, that eminent fish-culturist of many years' experience, made the following statement in "Outdoor Life" in 1935--a statement which I believe to be pertinent, at least insofar as protection is concerned:

> The only sure way to raise trout successfully is to do it in tanks completely screened from vermin. When the trout are 9 or 10 inches long they can be raised in ponds, if they get reasonable protection from birds and

other marauders. When the large fish are put out they remain in the stream only a short time until they are caught. In this way, losses to vermin are reduced to a minimum. Therefore, the really practical way to get the most for our money and efforts is to raise the trout in completely protected areas until they are big enough to be put into the streams or grown still larger in semiprotected ponds.

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FEEDING FINGERLING CATFISH

During the past season fingerling catfish were hatched and reared in regular trout trough at the U. S. Fish-Cultural Station, Neosho, Missouri. The water used was a mixture of pond and spring water, maintained at a temperature of 80°F.

As soon as the fingerling catfish had used up their yolk and had started to search for food along the sides of the trough, they were fed a prepared feed. This feed consisted of 50 percent crayfish abdomens, 16-2/3 percent fish meal, 16-2/3 percent cottonseed meal, and 16-2/3 percent dried skim milk, mixed and ground through a 5/64-inch chopper plate. Beef melts and livers were substituted for the crayfish abdomens several times. At first 1-inch pieces of the feed were placed on the bottom of the trough, but as the fish grew larger, the mixture was put through a potato ricer and fed in much the same way that the Cortland No. 6 diet is given to trout. Every week about a pint of daphnia collected from the culture ponds were placed in the rearing trough, and the catfish cleared these from the trough within a few minutes. A cover placed over the trough darkened about two-thirds of it, and the fingerlings remained in this darkened portion.

Distribution began in August with 2-inch catfish, 2- to 3-inch in September, and 3-inch fingerlings in October. A total of 7,108 fingerling fish was distributed; the total weight was 18 pounds. The mortality averaged one to three a day. No disease was encountered.

Next season, with an increased number of brood fish, fingerling catfish will be produced on a much larger scale. Plans are being made to keep a daily record of feed used and weight gained.

DUAL TREATMENT FOR BACTERIAL FIN ROT

George J. Eicher, Jr.
Arizona Game and Fish Commission
Phoenix, Arizona

AN OUTBREAK of bacterial fin rot was noted on February 5, 1946, in a group of rainbow fry at the Tonto Hatchery of the Arizona Game and Fish Commission. Extensive losses were sustained before any treatment was given. The writer was called in after the hatchery foreman's treatment with copper sulphate had been followed by considerable additional losses and no reduction of the incidence of the disease.

Learning that the copper sulphate had been ineffective, the writer felt that no further use of this should be made. The appearance of bacterial fin rot in other hatcheries has resulted in a number of investigations: Burrows (1941) has suggested formalin as a treatment for bacterial fin rot, and T. S. Kibbe (unpublished work, U. S. Fish and Wildlife Service) has found malachite green effective for certain types of this disease. The writer decided to try both treatments and discover which would be the more effective in this particular outbreak.

The diseased fish were fairly equally apportioned among 29 troughs, each of which was about 1 by 12 feet and contained 4 inches of water. The fish in 17 troughs, all on one side of the hatchery in use, were treated with formalin (1/2,000) for a 1-hour period during which the water was kept static in the troughs. Though no attempt was made to aerate the troughs, the fry went through the 1-hour treatment without showing any distress from lack of oxygen. The fish in the 10 troughs on the other side of the hatchery were given a flush treatment of malachite green, 2 ounces of a 1/40 solution being passed through the troughs. Two troughs were left untreated for controls.

At this stage, however, to facilitate the recording of losses, the writer decided to keep in balance the number of troughs that received the formalin and the malachite green. To effect this balance, within an hour after the original treatment, malachite green was added to the treatment given to 7 of the 17 troughs which had previously received formalin. By this arrangement the fish in 10 troughs received formalin, the fish in the second group of 10 troughs received malachite green, and the fish in 7 troughs received both formalin and malachite green; the same 2 troughs were still kept as controls.

Treatment losses that occurred during a 20-hour period are shown in Table 1.

Four days later the records showed the incidence of disease dropping fast in the troughs treated with malachite green,

TABLE 1.--Treatment losses in 20 hours

Treatment	Loss per trough
Formalin	312
Malachite green	19
Formalin and malachite green	371
Controls	20.5

See also:

Wright, Alice
1936. Report of four years experience with fin rot and some remarks on octomitiasis. Prog. Fish-Cult. 24: 1-27.

averaging slightly more than 10 fish per trough per day for the period. Mortality among fish treated with formalin averaged 67 per trough per day, while in the controls mortality remained more or less stationary at 24 per trough per day.

As the formalin had proved ineffective by this time, fish in those 10 troughs were also treated with malachite green, and the others (with the exception of the controls) were given another malachite-green treatment. After 4 days a curious condition developed. The control troughs were losing an average of about 80 fish per day, which was close to the original rate. The 10 troughs that received successive treatments of malachite green and the 10 originally treated with formalin and later given malachite green, were all on approximately the same level, losing about 20 fish per trough per day. On the other hand, mortality in the seven troughs treated with both malachite green and formalin had dropped to a point where the loss averaged slightly more than one fish per day per trough.

This prompted the treatment of all fish with the dual dosage, a treatment that was used thereafter. Losses dropped rapidly, but they did not stop for another week. It was interesting to note that although this was an extremely heavy infection--more than 95 per cent were infected--some 40 per cent were saved. Ordinarily, all fish infected with fin rot may be expected to die, only those untouched by the disease being saved. When the survivors were later removed to circular ponds outside the hatchery, however, it was observed that virtually all showed signs of having had the disease: the surviving fish had only healed-over stubs of pectoral and caudal fins. These fins later regenerated.

On August 10, 1946, the writer was asked to investigate an outbreak of disease among fry in the hatchery at Pinetop. Examination showed that these fry also had fin rot. Again it was decided to try several treatments in order to discover which worked best. Four troughs were treated with Roccal (1/50,000) for 1 hour, four were treated with formalin (1/2,000) for 1 hour, four were given a flush treatment with copper sulphate, two were given a flush treatment of 2 ounces of formalin and 2 ounces of malachite green (1/40). Two troughs were kept for controls. The treatment and overnight losses are shown in Table 2.

TABLE 2.--Mortality during study of Pinetop outbreak

Troughs	Treatment	Loss	
		Treatment	Overnight
Four	Copper sulphate	33	66
Four	Formalin	15	26
Four	Roccal	21	38
Two	Malachite-green and formalin	6	9
Two	(Control)	-	18

Although 1-day coverage was hardly sufficient to permit the drawing of any conclusions, the low treatment loss and overnight (24 hours after treatment) results seemed to point again to the desirability of using both malachite green and formalin. Because of pressing work elsewhere, the dual treatment was immediately applied in all troughs without any further experimentation with other medicines. Within 4 days all losses dropped considerably, although, as in the Tonto outbreak, losses did not stop for 2 weeks. Significantly, mortality cleared up sooner in those troughs originally given the formalin treatment and the dual treatment than in the others. Those troughs originally treated with copper sulphate suffered rather heavy losses for a few days.

These are but two outbreaks, and the results are somewhat incomplete. Therefore, it cannot be said either that the dual treatment is the answer to fin rot or that it will work in all cases and against all types of fin bacteria. These tests were made under practical hatchery conditions and so were not of a strictly technical nature. There is some indication of possibilities from this treatment, however, and it is hoped that someone else will try it further and report results.

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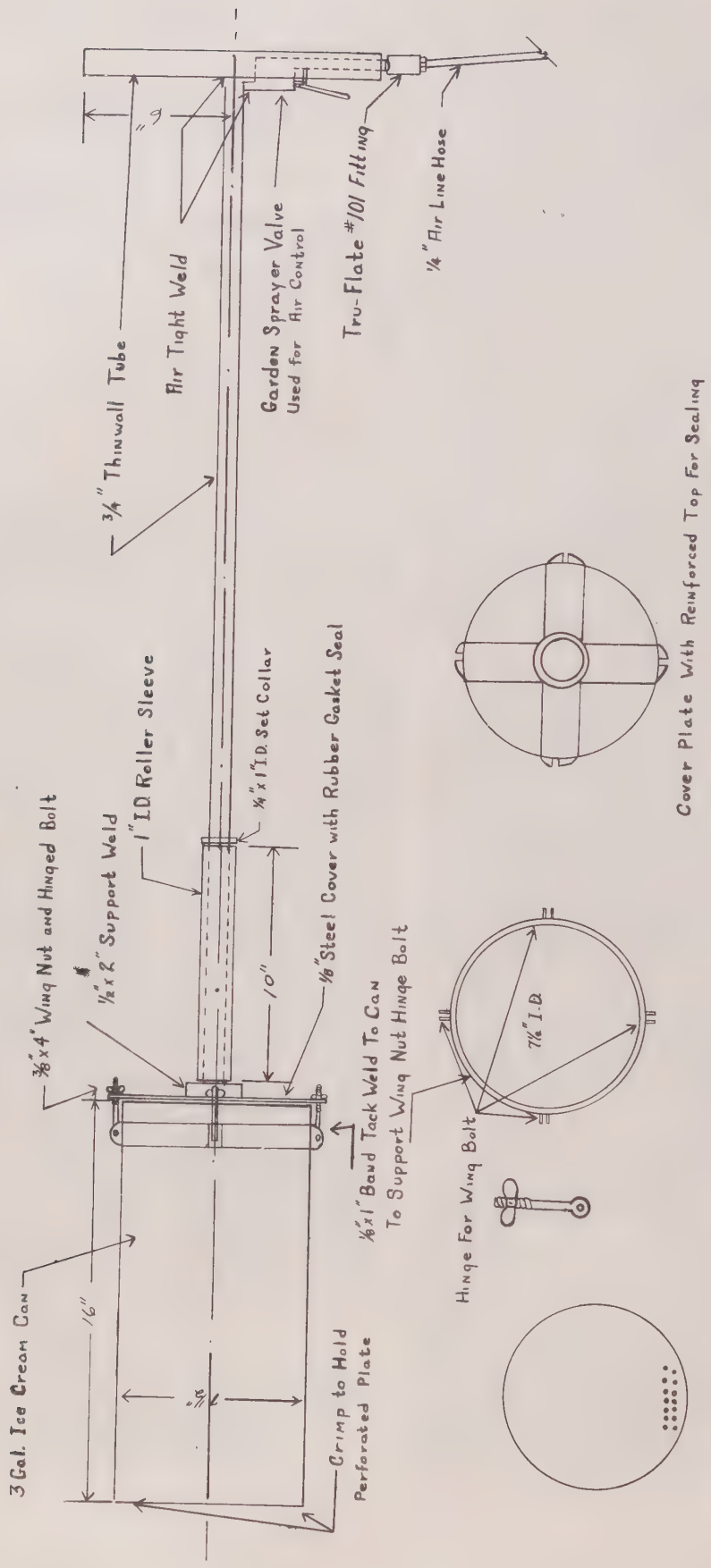
3/4" Thinwall Tube
Air Tight Weld
Garden Sprayer Valve
Used for Air Control
Tru-Flate #101 Fitting
1/4" Air Line Hose
9"
3/8"x4" Wing Nut and Hinged Bolt
1/2"x2" Support Weld
1" I.D. Roller Sleeve
1/4"x1" I.D. Set Collar
10"
1/8" Steel Cover with Rubber Gasket Seal
1/8"x1" Band Tack Weld To Can
To Support Wing Nut Hinge Bolt
Hinge For Wing Bolt
7 1/4" I.D.
3 Gal. Ice Cream Can
16"
Crimp to Hold
Perforated Plate
Perforated Steel Plate For Food Ejection. 3/32"x7 7/8" Dia.
Perforate to Size Required
Cover Plate With Reinforced Top For Sealing

COMPRESSED-AIR FISH-FEEDING
APPARATUS

APRIL 1947

COMPRESSED-AIR FISH-FEEDING APPARATUS

John Pelnar
Fish and Wildlife Service
Anderson, California

FOUR MEMBERS of the Coleman Station developed this compressed-air fish-feeding apparatus to improve fish-feeding practices and to reduce the costs and manual labor involved in a large-scale fish-rearing operation.

The apparatus permits the feeding of fish in ponds in an easy, convenient, and improved manner. Speed in feeding is not advocated, although this apparatus will feed as fast as is desired. The apparatus should be adapted to suit the conditions, size of stock, and area of the pond. The food should be dispersed over sufficient area so that all the fish may have ample opportunity to feed. The fish-culturists at Coleman favor the equipment because it reduces manual effort and is economical and satisfactory.

The apparatus developed at Coleman was fabricated from such materials as were in

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See also:

Burrows, R. E., and Manning, J. E.
1946. Enlarged ricer for pond feeding. Prog. Fish-Cult. 9 (1): 42-46.

Glenny, F. H.
1938. Water dissemination method for feeding fish by means of a water-distributing pipe line system. Prog. Fish-Cult. 36: 26-29.

Mitchell, C. R.
1941. Potato ricer in the fish hatchery. Prog. Fish-Cult. 55: 28-30.

Wales, J. H.
1935. Feeding of trout in California hatcheries. Trans. Am. Fish. Soc. 65 (1935): 305-308.

stock and available. This can probably be improved upon by others.

Air supply for the feeder at Coleman is furnished by means of an air compressor and air line to the pond system, then by 1/4-inch air hose to the feeder, at 20-pound pressure.

The feeder constructed in accordance with the drawing required the following:

3-gallon freezing can (ice cream)
Bolts, steel plate, pipe, and miscellaneous fittings
Garden-sprayer valve
25 feet of 1/4-inch air hose
2 Tru-Flate No. 101 fittings
Rubber gaskets
Labor to drill ejection plate, assemble feeder

The size of feeder indicated in the drawing is optimum. Should a larger food reservoir be desired, the length of the can may be increased, but caution is advisable when increasing its diameter.

The bottom of the 3-gallon can is removed, a small ridge being left to hold the plate. The plate (3/32-inch steel) is perforated with holes of a size to suit the particular food to be fed: holes of 1/16-inch diameter for small fish, larger holes for larger fish. Individual plates may be prepared to suit the size of fish being fed. A steel band (1/8 by 1 inch) with hinging pieces welded thereon is then tack-welded to the can near the top. Eye bolts (3/8 by 4 inches) are used, as well as hinge bolts with 3/8-inch wing nuts for use in tightening down the cover plate. The cover plate is of 1/8-inch plate reinforced with steel to form the clamp part of the eye-bolt hinge. A steel washer (1/2 by 2 inches) is welded to the top, serving as means of entrance for the air-pipe handle through a hole in the cover plate. The pipe handle is made of 3/4-inch I.D. tubing, and its length can be adjusted to meet conditions. The extreme upper end of this tubing is closed and the cross-arm tube then welded thereon. The air-supply control valve (we used a valve taken from a garden-sprayer assembly) is fitted into the cross arm and brazed to the air-supply tube as shown. The other end of the valve receives the Tru-Flate fitting and air hose. The air pressure is easily controlled with one hand, as the operator has the control valve in one hand at all times. The type of pond at Coleman also required that we install a roller sleeve just above the can to prevent undue wear in rubbing the handle on the projecting concrete and to ease the operation of the feeder in the swishing motion.

It is believed that almost any machine shop can construct the apparatus from the accompanying drawing and photographs. Our expenses amounted to $18.25, but commercial shops may be somewhat higher. As no moving parts are involved, very little maintenance and repair are necessary.

The operation of the apparatus is relatively simple though it requires a little practice for proficiency. The food reservoir is filled with the proper amount of fish food--for better operation, a tightly bound mixture of fish food. The cover plate is installed and bolted down by hand only. After the air hose is connected, the apparatus is ready to eject the food. By pressure upon the air-control valve, wormlike strings of food will be ejected from the perforated bottom; by swishing the can back and forth in the water, these strings will be broken into worms, which will float if the mixture is of the proper consistency. The speed of ejection is controlled with the air valve, as application of more air speeds up the delivery. A few trials will readily acquaint inexperienced personnel with the use of this apparatus.

WELL CASINGS FOR POND SCREENS

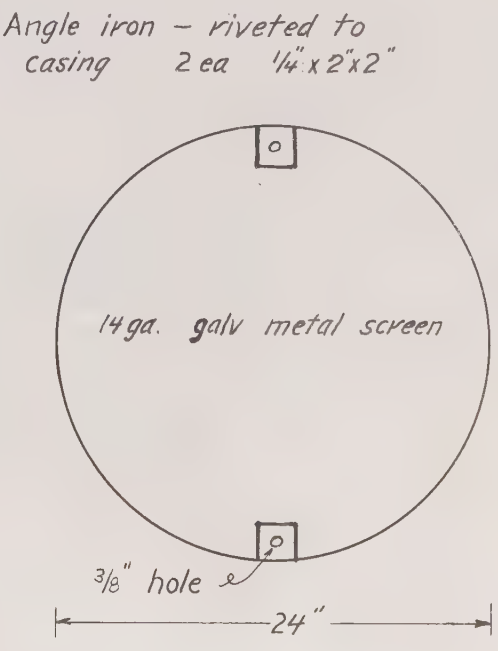
Fred A. Thompson
Department of Game and Fish
Santa Fe, New Mexico

FOR MANY YEARS fish-culturists have been interested in the improvement of screens for ponds. This is particularly true at that time of the year when screens need repair or when algae and debris cause additional labor and anxiety in keeping the water flowing freely. This interest is made manifest by the variety of screens found in each hatchery--screens built in accordance with the ideas of some worker at the hatchery or according to a plan drawn by a person who may be remote from the hatchery problems and perhaps knows nothing of the labor involved at a hatchery. In some hatcheries the screen building may have gone to the more elaborate, rotary self-cleaning type or even to the electrical-fence type.

The information in this paper is presented in an effort to (1) decrease the screen-cleaning labor, (2) standardize the screen frames to fit all forms in all ponds, (3) produce a screen that, because of its durability, will be serviceable for many years.

Our answer to these problems may now be found in the standard vertical-slotted well casing, which is supplied by nearly all large pipe-manufacturing companies. Size of slots in the casing ranges from 1/8- by 7/8-inch to 1/4- by 1-1/4-inch; slots are spaced as closely as the metal will allow or as desired by the manufacturer. Well casings are manufactured in various lengths, but the standard length is usually 3 feet; the diameter of the casing may be as much as 6 feet; and the thickness, depending upon stamping facilities, may be as much as 10 gauge. These are all standard specifications.

Circular ponds or pond drains sometimes require a circular screen. For this the perforated well casing of standard length can be used to advantage without alterations or additions, but it is desirable to weld or rivet opposite each other at the top end of the casing two 2-inch angle irons (1/4 by 2 by 2 inches),



See also:

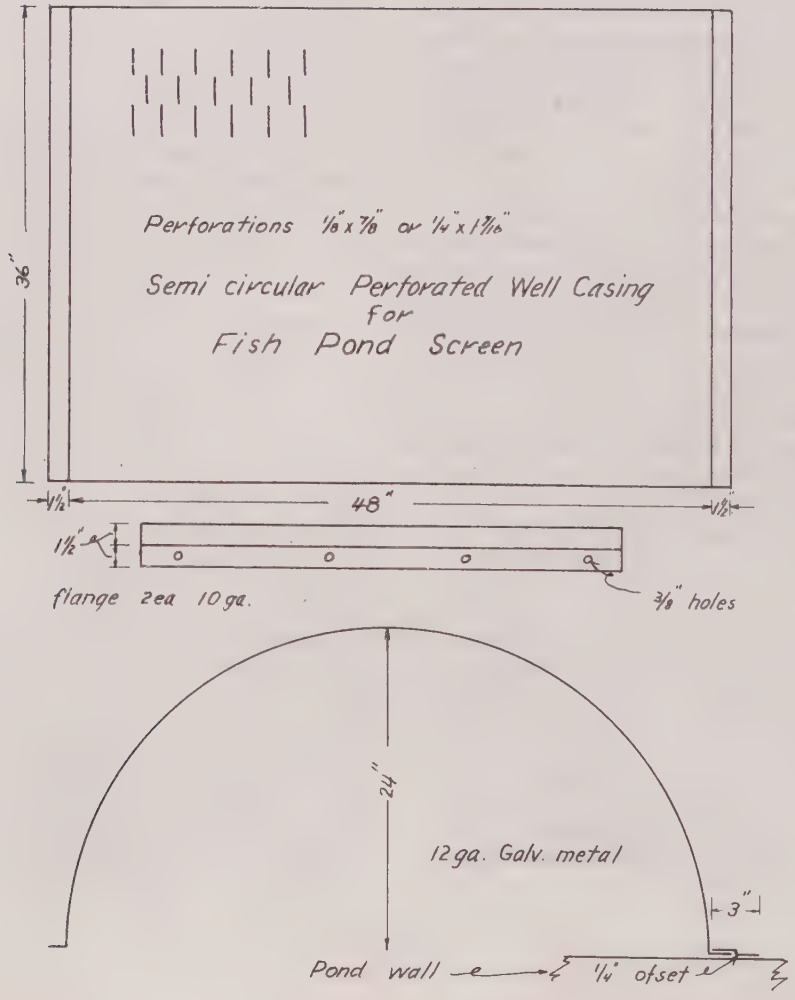
Fortney, R.
1938. Self-cleaning, revolving screen for use in brood stock and rearing ponds. (Letter to editor) Prog. Fish-Cult. 38: 22-26.

Lindgreen, O. W., and Spencer, J.
1939. Fish screen in irrigation diversions. (Based on reports) Prog. Fish-Cult. 45: 18-23.

each with a 3/8-inch hole drilled in the free arm. The casing will be held to the bottom of the pond by means of 3/8-inch rods hooked from eyes in the bottom of the pond, drawn up through the holes in the angle irons, and tightened with wing-nuts. Of course, to insure a tight fit at the bottom of the screen, it will be necessary to construct a true base for the casing to rest on if the pond is not lined with concrete.

Well casings are almost as readily adaptable for rectangular ponds with end or side drains, but some alterations are necessary in that a semicircular piece is required. For our needs the bisection of a casing 4 feet in diameter is recommended, but variation in size may be required to meet local conditions. On each side of the bisected casing 1-1/2 inches of the straight edge must be bent outward at almost a right angle or at an angle such that when the screen is placed up against a pond wall the turned edge will fit flat against the wall. The piece of casing will be held to the wall by a cleat on each side. The cleats are pieces of galvanized 10-gauge metal (3 feet long and 3 inches wide) offset longitudinally in the middle by 1/4 inch. Each cleat is bolted to the wall with three or four lag screws (shields required in concrete). After the cleats are installed (at a distance from each other equal to the diameter of the casing), the piece of casing is picked up, set into the cleats, and secured to the bottom of the pond with a long hook bolt reaching to an angle iron in the top of the casing.

All material should be galvanized, especially the casings and the cleats. The metal should not be lighter than 14 gauge; usually 12 gauge will prove most satisfactory. The process of punching the metal will cause the exterior of each slot to protrude. This protrusion tends to hold the debris away from the screen, allowing freer passage of the water. Too,



the elongated debris will head directly into the slot and the suction of the water will ordinarily pull it through; this is contrary to the action of debris on wire cloth.

For 6 years, with complete satisfaction of operation and minimum deterioration, the New Mexico Department of Game and Fish has been using perforated well casing (18- and 24-inch diameter) in its round ponds. Early this year the semicircular perforated well casing was installed in a few of the rectangular pond outlets and drains. This type of screen, also, has proved very satisfactory. The personnel who have assisted in the change from wire-cloth screens are eager to see a complete installation of the new screen.

The Service offers neither recommendation nor endorsement, but a list of firms supplying modified well casings might include:

Thompson Pipe & Steel Company
Larimer at 30th Street
Denver 1, Colorado

Hardesty Div'n of Armco Drainage
& Metal Products, Incorporated
3033 Blake Street
Denver, Colorado

Midland Pipe & Supply Company
2829 South 61st Court
Chicago 50, Illinois.

BARREL TILTING RACK

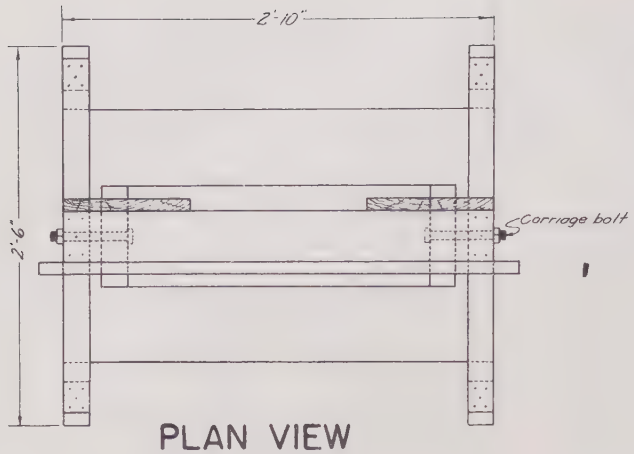
Blaine T. Gillette
Fish and Wildlife Service
Genoa, Wisconsin

The barrel-tilting rack is intended to facilitate the drainage of barrels and drums. It is a labor-saving device, as well as a safety measure for the protection of those required to tilt heavy containers of grease and oil.

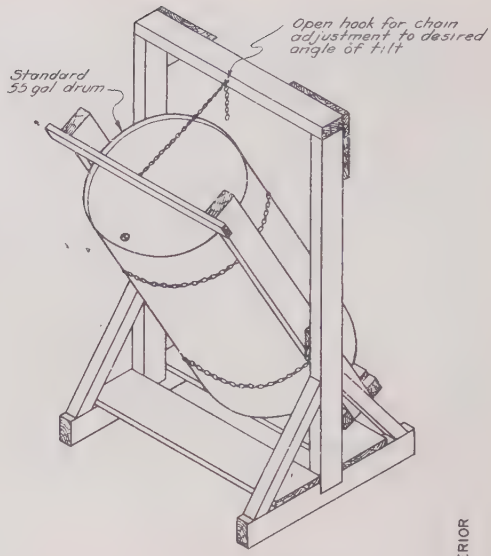
The tilting rack is simple in design, being made of wood and a small amount of hardware. Wooden standards, well braced, with wide footings to prevent overturning, are constructed and placed together. Within these standards is put a swinging rack that pivots by means of two bolts that hold it to the standards. The pivot bolts are set off-center on the rack height, as shown in the drawing, in order that the barrels or drums will easily tilt downward for draining purposes. A chain fastened to the sides of the swinging rack holds the barrel in place, and another chain at the top of the rack regulates the degree of the tilting. Casters at the corners will permit easy movement of the rack.

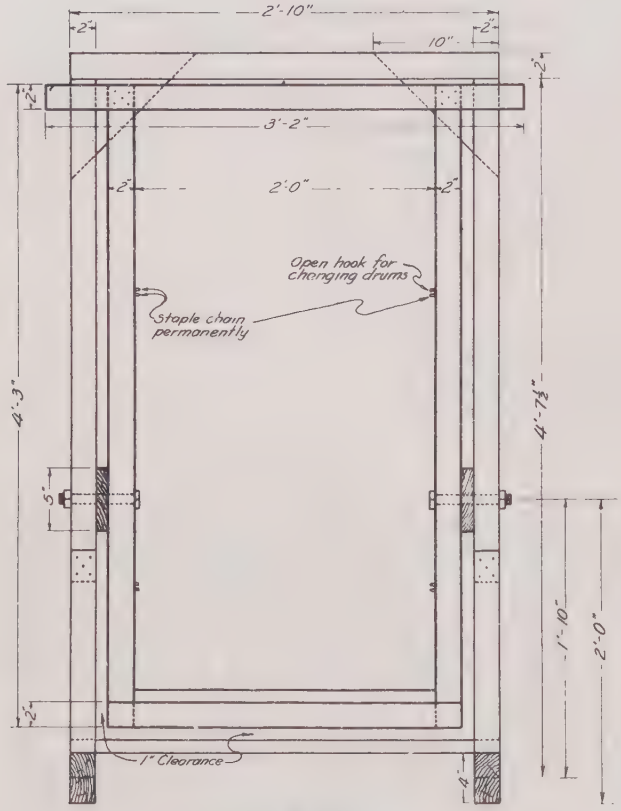
The accompanying diagram shows the construction of the barrel-tilting rack to accommodate a 55-gallon barrel. With some alteration of the measurements, this tilting rack may be constructed for any ordinary barrel or drum size desired. Construction will require only a very small expenditure.

See the following page.

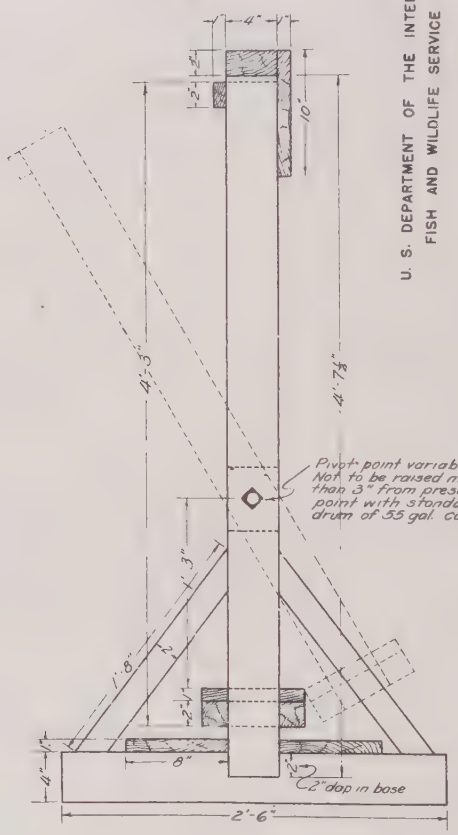


PLAN VIEW





ELEVATION



SIDE VIEW

U. S. DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

BARREL TILTING RACK

If the wood of the barrel is unusually thick, it may be advisable to increase the width by an inch.

SCREEN FRAMES THAT SEAL

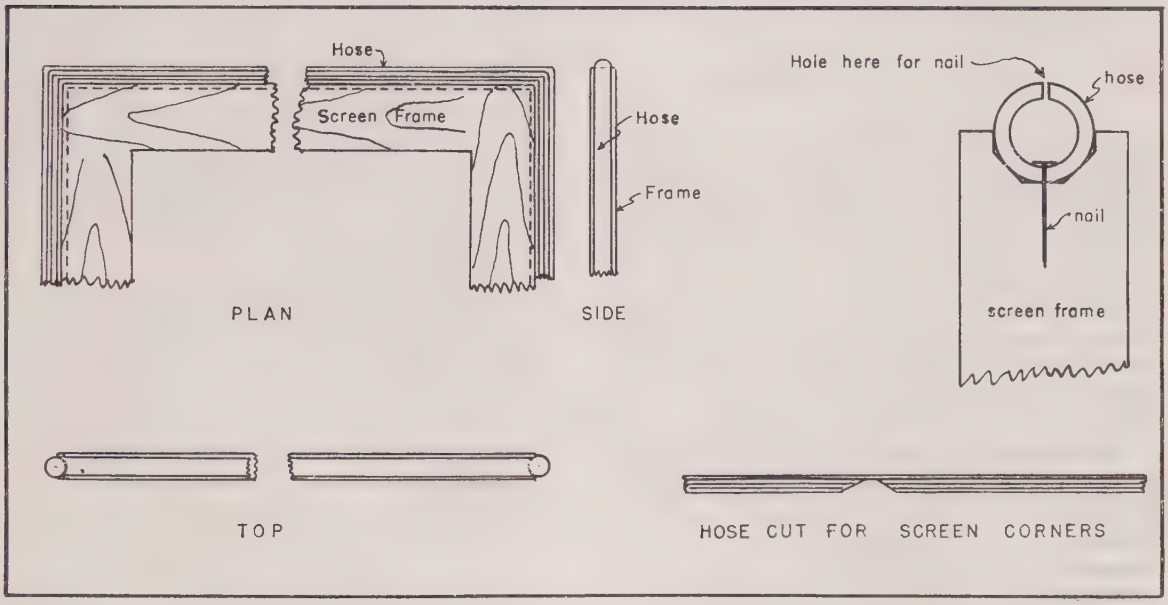
Walter M. Allen
Fish and Wildlife Service
Miles City, Montana

Every fish-cultural station has had trouble with the problem of fitting screen frames into concrete outlets. At the Miles City Station this difficulty has been solved with a table saw and some old garden hose.

Before the screen frame is put together, the 2 by 4--or 2 by 6, or whatever stock is used--is grooved to permit insertion of one half of the hose. The over-all width of the frame, including the protruding portion of the hose, should be the width of the screen-frame opening in the outlet.

When the hose is inserted for the first time, it should just slide freely into the groove. When the wood expands, the hose takes up the expansion, so that the groove becomes a tight fit.

By this arrangement there is no need to guess at the amount of expansion of the wood. The screen frames fit tightly enough to keep in small fish but can be removed easily at the end of a season.



FROM PUBLICATIONS

REPRINT

USE OF DERRIS TO RECLAIM PONDS FOR GAME FISH

Hilbert R. Siegler and H. W. Pillsbury
Fish and Game Department
Concord, New Hampshire

Fish and game managers find it desirable on occasion to eradicate the animal life of a lake or stream, and rotenone has proved useful for the purpose. Literature describing the method of using this drug in fish management is scattered and meager, and other workers may benefit from experiences with it in New Hampshire where 20 lakes have been poisoned and reclaimed for trout since 1938.

History and Experiments

Rotenone is found chiefly in derris (Derris elliptica and Lonchacarpus nicou) and there are many references to its various uses as a poison; Roark (1932) gives over 450 references on derris. Since 1932 the use of derris has expanded rapidly, with corresponding increase of publications on this material. Most of the articles deal with derris as an insecticide, but some references to fish poison are made.

The rapidly expanding use of derris led to considerable research on the effect of this poison on man. In general limited quantities of derris are not fatal to humans. Haeg (1931) took 2.3 grains and suffered no harmful effects. Previously Buckingham (1930) stated that pure rotenone given to dogs at rates up to one grain per pound of body weight had no apparent ill effects. Our experience with derris leads us to recommend use of a nose and mouth mask while handling the powder, as it is difficult to avoid breathing and swallowing some when mixing with water in open barrels. We suffered no serious after-effects, but experienced uncomfortable constriction of the throat muscles for several hours afterward. Buckingham worked with warm-blooded animals, and Gersdorff (1930) made a series of tests on the toxicity of rotenone on fish, using goldfish as the test species (Gersdorff, 1930a, 1930b, 1931, and 1937). A comprehensive paper by Leonard (1939) sums up experimental work to that year, including his own findings.

In 1938 the late Earl Hoover pioneered in reclaiming many New Hampshire lakes and streams (Hoover and Morrill, 1938). Other early workers in practical application of this drug to fish management were Eschmeyer (1937, 1938, 1939), McGonigle and Smith (1938), Smith (1940, 1941), and Hagen (1940). Hoover's next operation was of a scope then believed impossible by other workers, the reclamation of 358-acre Back Lake in Pittsburg, N. H. That lake had previously been poisoned with copper sulphate with only moderate success, and by 1938 was overrun with pickerel. In September 1938 the lake was reclaimed by use of derris (0.153 p.p.m.) with complete success. During the next few years 10 other lakes were reclaimed, using various methods for calculation and

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Reprinted from the Journal of Wildlife Management, 10 (4): 308-316, October 1946.

application. The war interrupted these experiments until August 1945, when derris again became available. This paper reports chiefly on the results with seven ponds since that date.

Preliminary Considerations

The following factors should be considered when poisoning operations are contemplated: accessibility of water to be reclaimed, water sources, outlet, water temperature (or time of year), depth and volume of water, rotenone content of derris, and research possibilities.

It is important to determine the accessibility of the water to be reclaimed, since considerable equipment and derris powder must be transported. For large lakes the total weight often will be several thousand pounds.

The degree of success depends largely on how thoroughly inlet waters are poisoned. If all waters at, around, and above the lake cannot be reached with poison, there can be no guarantee of a complete kill. Large marshes and swamps are difficult to spray thoroughly; unless they can be completely drained, fry or small species of fish will survive. This is the largest single cause of failure.

Work at the lake outlet, preparatory to poisoning, will generally entail the most labor and the greatest cost. Due to the present limited knowledge, we believe that no water should be poisoned that cannot be held for a minimum of three weeks before overflowing. According to laboratory tests by Leonard (1939), the toxicity of commercial powdered derris root at 1.0 p.p.m. (with warranted rotenone content of 5 per cent) dropped below the lethal point for common sunfish and bluegills in 20 to 41 hours after preparation. Brown and Ball (1942) in field tests found the toxicity in unfavorably cold water lasted seven days. In our field operations there was wide variation in the time that the toxic effect of rotenone was maintained in different lakes.

Seven ponds were reclaimed within 40 days (Table 1). Two were ready to be stocked with brook trout 35 days after being poisoned, and two others after 43 days. On the fifty-fourth day after poisoning a fifth lake (Carr Pond), brook trout died within 50 minutes after being introduced, although the concentration of rotenone used was slightly less than in the first four lakes. Two other ponds were poisoned on October 1 and 17. They remained toxic throughout the winter and would not support fish life until the spring turnover. In both cases water from these lakes flowed over the spillways about four weeks after poisoning operations, without any noticeable ill effect on fish in the streams which received this toxic water.

It becomes apparent that the water temperature or the time of year are important in poisoning operations. Leonard (1938), Greenbank (1940), Smith (1940), and Brown and Ball (1942) have all emphasized the fact that the toxicity of rotenone increases rapidly as the water temperature rises. Experiments by Leonard (1938) demonstrated that an increase in water temperature from 60° to 74° F. almost halved the time in which fish were killed. Brown and Ball (1942) state that rotenone did not affect their experimental fish at 45° F. or lower. The water temperatures when poison was applied to lakes in New Hampshire during 1945 are shown in Table 2. Our experience indicates that at water temperatures down to 48° F., rotenone will kill the fish of a lake effectively but not rapidly. The colder the water, the longer time needed for the poison to become dissipated. If poisoning operations are carried on late in autumn and cold weather soon begins, the water may remain toxic until the seasonal turnover in spring.

A knowledge of the depth and volume of water are prime requisites. Careful soundings should be made to afford a reasonably accurate calculation of volume. Time being limited we used a faster, less accurate, but effective method to determine the water volume, merely multiplying the surface acreage by the maximum depth. ("Maximum depth" excludes any occasional deep spring hole or ravine on the lake floor.) We thus overestimated the water volume, and increased the cost, more derris being used than necessary. On the other hand the added factor of safety and the greater speed and ease of this method justifies its use in some instances. There is still some question as to the

effectiveness of derris in deep water where a thermocline is present. Greenbank (1940) states that derris is much less effective in colder water (Leonard, 1939), and probably does not reach the lower depths in any appreciable amount, as a thermocline may prevent penetration of the poison to the deeper water. Our experience with three lakes did not wholly substantiate this viewpoint, as Round Pond (depth, 55 feet), Center Pond (33 feet), and Newell Pond (28 feet) all were poisoned successfully; each had definite thermoclines.

The rotenone content of the powder must be considered before calculating the poison required. Most reports to date are based on a 5 per cent assay, therefore allowance must be made for lower percentages. Powder ranging from 3.7 to 4.55 per cent rotenone has been used in New Hampshire with complete success.

TABLE 1.--Effects of derris poisoning in New Hampshire ponds.

Pond	Date poisoned (1945)	Concentration, p.p.m.	Days water remained toxic to brook trout
Harris	Sept. 6	1.96	Less than 43
Middle	Sept. 12	2.18	Less than 35
Moose	Sept. 12	1.98	Less than 35
Big Brook Bog	Sept. 13	1.95	Less than 61*
Carr	Sept. 17	1.85	More than 54
Newell	Oct. 1	0.576	More than 137
Center	Oct. 17	0.465	More than 129

* Inaccessibility precluded earlier checking.

TABLE 2.--Derris concentrations used, water temperatures, and rate of effect on fish in New Hampshire ponds

Pond	Concentration,* p.p.m.	Water temperatures, °F		Minutes until first fish surfaced	Time to final kill, hours
		Maximum, surface	Minimum, bottom		
Harris	1.96	74	--	30	2
Middle	2.18	69	62	20	5
Moose	1.98	68	66	15	18
Big Brook Bog	1.95	70	--	30	3
Carr	1.85	58	--	45	
Newell	0.566	64	50	30	20
Center	0.365	63	48	60	26

* Based on water volume as maximum depth x surface acres, not actual volume.

Finally, since pond reclamation work is comparatively new, no worker should omit the opportunity for much needed research. Some problems much in need of study are: (1) the effect of rotenone on both zoo- and phyto-plankton, and the length of time required for plankton to regenerate in ponds; (2) the effect of rotenone on bottom organisms; (3) the threshold of toxicity for various species of fish, and the use of rotenone in selective poisoning; (4) a chart showing the rotenone concentration needed to poison fish for every 5° F. change in water temperature; (5) the fertilizing value of dead fish to a lake; (6) the effect of

thermal stratification on poisoning operations; (7) the possible use of aircraft for distributing derris over large swamps; (8) an antidote to counteract the effect of rotenone on valuable game fish; and (9) the use of rotenone in streams.

Derris Requirements

After the concentration of poison to be used has been determined, a formula is used to determine the necessary weight of powder required, as follows:

$$\frac{\text{total acres} \times \text{average depth} \times 43{,}560 \times 62.5}{\text{p.p.m. required (.5 p.p.m. average concentration)}} = \text{pounds needed}$$

For rapid field estimates, surface acres x depth in feet x 1.36 = approximate pounds required. A material saving can be made by using various concentrations, depending on the conditions involved. Table 2 shows the range of poison concentrations used in New Hampshire, the water temperatures, and the time required to kill the fish population.

Methods of Application

Application is possible by several methods, but in New Hampshire practically all have been abandoned in favor of spraying. In our original work, sacks were towed on the surface and others weighted for deep water. In shallow water paper bags filled with a thin batter of derris were thrown out from the shore as far as possible; the moisture-weakened bags would break on impact and release the poison. Men wearing waders and carrying sacks also were used. Bombs made with dynamite in a gallon can of batter were used in Round Pond where there was distinct stratification and deep water. Dynamite is considered essential for a complete kill under floating islands. Large springs need special consideration. Several charges of dynamite or a sack of poison so placed that all water from the spring must pass through, were used successfully in our operations. Spraying was tried first in 1939 with an apple spray rig. On the first attempt, the efficiency with which an even distribution is obtained became evident. Hagen (1940) tried the same method at about the same time and with success. The importance of even distribution over the entire surface as simultaneously as possible cannot be overstressed. Light weight "Indian" pumps now are used for shoal areas. Two men in a canoe with such pumps can easily reach water that was nearly inaccessible by the older methods of wading along mucky shores or by dragging bags from boats. Spraying also has brought a change in procedure for covering the entire area of a lake. Barrows (1939) describes the former method of strip treatment of the surface by a man assigned to each strip. Where help is plentiful, this method may still be used to advantage, but it can be too expensive. Our method now is to leave all equipment and poison at one station or two (if the lake is large) and start to apply the poison in a continuous spiral around the pond in a counter-clockwise direction. Since most men work the pump with the right hand, this direction is easier than the reverse. If there is a high wind it is easier to work downwind. One canoe or other boat of slight draft starts within 25 feet or less of the shore, and a second boat immediately behind 25 feet out from the first. The third and other boats do similarly, and maintain their relative positions throughout the operation. The lake is covered completely, much as a large field would be gang-plowed. There are no "streaks" of poison as in application with sacks or pouring into the wake of an outboard motor. It is our practice to spray freely all marsh or swamp areas and every inlet. This includes waters that might drain into the pond, even when no water is flowing at the time of reclaiming. A special boat with power sprayer is now being designed. The key to successful poisoning may be an even and rapid distribution of rotenone throughout the water.

Disposition of Dead Fish

The dead fish are somewhat of a problem in reclaiming lakes. Where a study of them is to be made, all the killed specimens can be preserved. Valuable data on growth, weight, and other matters can be learned from study of an entire population. This, however, involves considerable expense which cannot be justified by a fish culturist who must show maximum return for dollars spent. On routine reclamation jobs it is of greater benefit to leave all fish in the water (where public relations do not dictate otherwise) as added fertilization to the pond. Fish that wash on to the shore do not present any problem if the operation has been handled properly. By drawing off a few inches or feet of water, the shore line will be lowered, and dead fish on the shore will decompose; then when the water is raised to the normal level, these fish will be well below the shore line. A few pounds of fish per acre provide a considerable weight of fertilizer.

Cost of Operations

Various methods of computing costs for this type of work have been used, cubic feet, gallons, or surface acres being the units often mentioned. We have adopted the acre-foot as the most easily understood unit; it is essentially accurate for all practical work. Figures computed to the nearest acre-foot will give an accuracy down to less than 1.5 pounds of poison required for derris concentrations of 0.5 p.p.m. Table 3 provides a general indication of poisoning costs per acre-foot, not including costs of any large or permanent dams that may have been constructed, permanent equipment, or salary of technicians. Man-hours in normal preparation and in actual poisoning, and the costs of poison and other expenses requisite to all reclaiming operations have been used. The cost of derris is on a sliding scale dependent upon the rotenone content, and a recent price of $0.40 per pound for a 5 per cent assay has been used for these figures.

The cost of $4.75 per acre-foot on Big Brook Bog shows clearly the sharply increased expense for reclaiming swampy or marshy areas. As the percentage of swamp or marsh present increases, the efficiency decreases. The controlling factor is the physical impossibility of covering such areas. When spraying from aircraft becomes feasible, such handicaps may be overcome. At present such areas should be avoided because of the expense and uncertain results. The average cost of operations on the seven lakes reclaimed was $1.41 per acre-foot. Reclamation work is rapidly passing out of the experimental stage, and the attitude of "using twice as much to be safe" should gradually be eliminated. More harm than good may result from over-poisoning; the lowest possible concentrations that will be completely effective should be used. The breaking of a temporary dam, whereby heavily poisoned water escapes, could effectively eradicate entire populations in streams or ponds below. Many workers like to call this over-poisoning their "safety factor." Reasonably accurate calculations will eliminate the added danger and expense.

Summary

Lakes up to several hundred acres in area can be reclaimed satisfactorily for game fish with rotenone. The expense is probably the major limiting factor. For economic reasons the accessibility of ponds should be considered in any extensive program.

Unless all head waters and marshy shore areas can be covered entirely there is little probability of a complete kill. Arrangements should be made to hold all water as long as possible; certainly not less than three weeks.

Rotenone will kill the fish population of a lake effectively but not as quickly with water temperatures as low as 48° F; however, the colder the water, the slower the poison becomes dissipated. Lakes poisoned late in autumn may remain toxic to fish until the seasonal turn-over of water in spring.

Water volume calculations to the nearest acre-foot are accurate enough for all practical purposes in poisoning operations. Calculations based on the weight of derris powder to water weight must be corrected for rotenone content. A 5 per cent assay has been generally accepted as standard.

TABLE 3.--Cost of derris application per acre-foot in relation to concentration in New Hampshire ponds

Pond	Acre-feet	Concentration, p.p.m.	Labor, hours	Cost	
				Acre-foot*	Totals
Harris	51	1.96	30	$2.59	$132.09
Middle	64	2.18	35	2.73	174.72
Moose	90	1.98	43	2.47	222.30
Big Brook Bog	30**	1.95	82	4.75	142.50
Carr	75	1.85	53	2.57	192.75
Newell	225	0.576	80	.93	209.25
Center	500	0.465	158	.78	390.00
Totals	1,035				$1,463.61

* $1.00 per man-hour, but services often donated.
** Exclusive of surrounding marsh.

Concentrations of 0.153 to 2 p.p.m. of derris powder to water volume have been used with success in New Hampshire, depending on water temperatures and species of fish to be eradicated.

Spraying is the most satisfactory method of application, although this may be supplemented by dynamite under special circumstances. "Indian" pumps have proved very effective in shoal areas.

The fish population should be left in the water as fertilizer wherever possible. The offensiveness of decayed bodies is reduced to a minimum if the water level has been lowered before poisoning.

Cost in New Hampshire is based on the acre-foot unit. The cost of reclamation operations on seven lakes averaged $1.41 per acre-foot and varied from $0.78 to $4.75.

Bog ponds are expensive to reclaim and the percentage killed is necessarily low.

The length of time lakes remain toxic to fish after rotenone is applied varies considerably depending on water temperatures. Of seven ponds poisoned, two could be restocked within 35 days but two others remained toxic to fish all winter.

There are still many problems in lake reclamation work much in need of study; nine of these are listed.

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ABSTRACTS

AMERICAN FISHERIES SOCIETY

Through the courtesy of Dr. Russell P. Hunter (Secretary) and Dr. Ralph Hile (Chairman of the Committee on Publications), the following abstract of a paper presented at the 76th Annual Meeting of the American Fisheries Society has been made available for publication in the PROGRESSIVE FISH-CULTURIST:

SURVIVAL AND GROWTH OF FINGERLING TROUT REARED UNDER DIFFERENT HATCHERY CONDITIONS AND PLANTED IN FAST AND SLOW WATER

Howard A. Schuck and Oliver R. Kingsbury
Conservation Department
Albany, New York.

Data obtained on Crystal Creek (New York) relative to the effectiveness of planting brown trout in slow and in fast water are presented. Of three plantings of fingerlings made throughout the stream length, annual inventories conducted with an electric shocker showed a significantly greater number of fish present in fast-water sections than in slow-water sections. Of the June 1940 planting, 20.2 trout per fast-water section and 10.1 per slow-water section were found after 3 months; of the September 1941 planting, 6.8 per fast-water section and 2.6 per slow-water section were found after 1 year; of the October 1940 planting, 1.00 per fast-water section and 0.62 per slow-water section were found after 1 year. In other experiments over a summer period only, where fish were planted in screened-off areas of fast or slow water, inventories after short periods of time also showed the survival to be greater in fast water. Of two plantings, after 4 weeks there were 2.2 times as many fish surviving in the fast water as in the slow

water. Growth rates of planted trout in both series of experiments were also greatest in fast water.

FROM OTHER SOURCES

THE DISINFECTION OF TROUT EGGS CONTAMINATED WITH Bacterium salmonicida. L. L. Gee and W. B. Sarles. Jour. Bact. 44 (1): 111-126. (July 1942).--The authors have made a well-controlled study of the effects of a number of disinfectants upon the causative organism of furunculosis. The germicidal powers of the disinfectants tested have been determined for B. salmonicida alone and in the presence of fish eggs, and their toxicity determined for living, eyed trout eggs. The disinfectants are listed below in the order in which they proved useful. The solution percentages given are for use in 10-minute treatments of eggs.

Disinfectant	Percent solution
Recommended:	
1. Sulfo-merthiolate (Lilly)	0.015
2. Acriflavine	0.185
Safe:	
3. Mercuric chloride	0.0025
4. Mercurochrome	0.68
5. Chlorozene (Abbott)	0.009
6. Mercarbolide (Upjohn)	0.0052
7. Calcium hypochlorite (B-K powder)	0.026
Usable but dangerous:	
8. Iodine	0.0056
9. Azochloramid (Wallace & Tiernan)	0.001
10. Gentian violet	0.15
11. Sodium hypochlorite (Klenzade)	0.062
Extremely dangerous:	
12. Formaldehyde	0.53
13. Metaphen	0.0099
Not usable:	
14. Clymocol	
15. Phenol	
16. Hexylresorcinol	
17. Malachite green	
18. Brilliant green	
19. Potassium permanganate	

FISCHEREIWISSENSCHAFTLICHE PROBLEME IN DEUTSCHEN ALPENSEEN. Wilhelm Einsele. Fischerei-Zeitung 44 (45/46): 1-16. (1941) Biol. Abs. 20 (3): 4414.--Stocking in the Bodensee with hatchery-raised coregonid fry did not increase production in the years when these fish should have reached maturity. About 0.001 percent of the coregonids hatched in nature reached the fishermen's nets. The size of the plankton crop is an important factor in percentages of survival of coregonid fry. Increasing the plankton increases the survival of fry proportionally. The size of the plankton organisms available at the critical time is important as the plankton are caught individually by the fry and even by the older fish. The light concentration is also important, and it is possible that many fish may die if the ice is snow-covered for long periods, because they cannot see to eat. Fish 20 millimeter in length eat about 500 plankton a day; fish 30 millimeter, 1,000 a day. Best result was obtained by stocking with fingerlings 25 to 30 millimeter long. In one lake 10,000 fingerlings were stocked; within 4 years, 10 percent were caught by fishermen.

LIMNOLOGICAL STUDIES IN CONNECTICUT. VIII. THE NIACIN CYCLE IN A SMALL INLAND LAKE. G. E. Hutchinson and J. K. Seton. Ecology 27 (1): 13-22. (1946).--This investigation dealt with the vitamin (niacin) content of inland water. The concentration of dissolved niacin in the surface waters varied from 0.15 to 0.89 gamma per liter,

the highest values occurring during the winter.

CALCULATION OF FISH CONDITION FROM SCALE DIMENSIONS IN THE BLUEGILL, Lepomis macrochirus. Herman B. Chase. Ecology 27 (2): 182-184. (1946).--A method of estimating weight and condition at various times by means of the scale record has been devised for the bluegill. The first annulus is not well fitted to the formula. Measurements of the scale are the length (largest anteroposterior axis through the focus) and the width (lateral axis through the focus). The measurements are from a projection apparatus with a magnification X-41.02. Averages of 10 or more scales should be used. Measurements of total length, depth, and thickness are taken to the nearest tenth of an inch, and weight to nearest hundredths of a pound. The formulae are based on averages from ventral scales taken from the row behind the pectoral fin and continuing along the ventral side of the peduncle, in line with the anterior spine of the anal fin. For fish 3.5 or more inches in length:

$$Wt = \frac{Wa^3 \text{ (or } Ws^3)}{3400} \qquad L = \frac{La \text{ (or } Ls)}{1.285}$$

Where Wa = width of the scale at an annulus, La = length of scale at an annulus, Wt = weight of fish (pounds), and L = length of fish (inches). The condition factor C has been corrected to apply to any length of fish:

$$\frac{6}{L} \times C = CC \text{ (corrected coefficient of condition)}$$

$$C = \frac{Wa^3}{3400L^3} \qquad CC = \frac{.00176Wa^3}{L^4}$$

Where dorsal scales are used instead of ventral scales, additional correction must be made.

A PRELIMINARY REPORT ON FARM POND MANAGEMENT IN MICHIGAN. Peter I. Tack and W. F. Morofsky. Mich. Agr. Exp. Sta. Quart. Bull. 28 (4): 1-10. (May 1946).--Results are given on the fertilization of experimental ponds at the Michigan State College Lake City Experiment Station in 1944-45. Where a 7.5-15-3.75 (N-P-K) fertilizer mixture has been used, there has been a great increase in the production of the aquatic insects and in the average size of bluegills when compared with the results from unfertilized check ponds. The weights of fish produced are not given.

OBSERVATIONS AND EXPERIMENTS ON THE CAVE FISH Pimelodella kronei AND ITS RELATIVES. C. Pavin. Am. Nat. 80 (792): 343-361. (1946).--Pimelodella kronei is a cave-inhabiting Brazilian catfish. All of 114 specimens collected by the author were found to lack any visible vestiges of eyes or optic nerves. Specimens collected by other workers included a few individuals with rudimentary eyes and optic nerves. P. transitoria, a related catfish with eyes, was able to change its coloration rapidly to correspond with changes in the color of the background. This ability was lost upon destruction of the eyes of this species. P. kronei also was unable to make rapid changes but would gradually develop a dark pigmentation if exposed to daylight for weeks or months. The injection of an alcoholic extract of fish pituitary glands caused the rapid contraction of the pigment cells, and the fish became visibly devoid of pigment and remained so for several hours.

PRELIMINARY OBSERVATIONS ON THE STORAGE OF THE MILT OF TROUT. A. D. Butcher. Australian Jour. Sci. 7 (1): 23-25. (1944) Biol. Abs. 20 (3): 4412.--The milt of brown trout may be stored successfully at least 5 days by covering with a layer of boiled B. P. Paraffin liquidum and storing at a temperature of 2.2 to 3.3°C.

CLEARING HOUSE

As a convenience for those interested in the various phases of fishery work, the PROGRESSIVE FISH-CULTURIST proposes to list in each issue recent publications on fishery topics. At present there is no current listing of new and pertinent publications. In order to keep up with new literature relating to their work, men in the field must now depend upon private correspondence, a few tardy abstracts and reviews, and personal contacts. Thus it is suggested that any State, institution, or other source that publishes a bulletin on farm-pond management, fish culture, fishery research, or other subject of interest to the fishery field in general, furnish the PROGRESSIVE FISH-CULTURIST with the name of the publication, the name of the author, the source from which copies may be obtained, and, if possible, a copy of the publication.

CARE AND DISEASES OF TROUT. H. S. Davis. U. S. Department of Interior, Research Report 12, 98 pp., illus. (rev. ed. 1946) For sale by Superintendent of Documents, Washington 25, D.C. Price, 35 cents.

This is the third and most extensive revision of Care and Diseases of Trout. Care of trout at the hatchery, including the care of ponds and raceways, is treated at some length. This is followed by a general discussion of trout foods and methods of feeding, special attention being paid to the use of dry products for supplementing fresh meat in the diet. Some consideration is given to the improvement of brood stock and its practical value.

A general discussion of parasites and diseases of trout, and their control, is followed by a detailed account of each disease, including the characteristic symptoms, etiology, pathology, and methods of control. The figures include drawings and photomicrographs of the more important organisms that cause trout diseases and their effects on the tissues.

DDT: ITS EFFECT ON FISH AND WILDLIFE. Clarence Cottam and Elmer Higgins. U. S. Department of Interior, Circular 11, 14 pp. 1946. For sale by Superintendent of Documents, Washington 25, D. C. Price, 5 cents.

This bulletin was prepared with the hope that it would help guide entomologists and other control operators and the general public who may have need to apply DDT to control insects and other invertebrate pests. It was written to answer the many inquiries received concerning the effects that DDT has upon the fishery and wildlife resources. The report is preliminary and far from complete although it presents a brief summary of the known effects that DDT has upon the fishery and wildlife resources of the country.

FRESHWATER FISH OF VICTORIA AND THEIR FOOD. A. Dunbavin Butcher. Chief Inspector of Fisheries and Game, Melbourne, Australia. 1946.

EDITORIAL STAFF

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